Will the COVID-19 pandemic affect population ageing in Australia?

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Abstract

The COVID-19 pandemic has caused extensive disruption to economies and societies across the world. In terms of demographic processes, mortality has risen in many countries, international migration and mobility has been widely curtailed, and rising unemployment and job insecurity is expected to lower fertility rates in the near future. This paper attempts to examine the possible effects of COVID-19 on Australia's demography over the next two decades, focusing in particular on population ageing. Several population projections were prepared for the period 2019–41. We formulated three scenarios in which the pandemic has a short-lived impact of 2–3 years, a moderate impact lasting about 5 years, or a severe impact lasting up to a decade. We also created two hypothetical scenarios, one of which illustrates Australia's demographic future in the absence of a pandemic for comparative purposes, and another which demonstrates the demographic consequences if Australia had experienced excess mortality equivalent to that recorded in the first half of 2020 in England & Wales. Our projections show that the pandemic will probably have little impact on numerical population ageing but a moderate effect on structural ageing. Had Australia experienced the high mortality observed in England & Wales there would have been 19,400 excess deaths. We caution that considerable uncertainty surrounds the future trajectory of COVID-19 and therefore the demographic responses to it. The pandemic will need to be monitored closely and projection scenarios updated accordingly.

Keywords COVID-19 · Population projections · Scenarios · Australia · Population ageing

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Introduction

The COVID-19 pandemic has clearly caused severe economic and social disruption across the world. To try to limit the spread of the disease, many governments have implemented temporary restrictions on personal mobility, the crossing of state and international borders, social gatherings, workplace attendance, and which retail establishments are allowed to remain open. As a consequence, economic activity has declined and unemployment risen, resulting in severe financial stress for many households. Many social and recreational activities, including visiting family and friends, attending sports and entertainment venues, and going on holiday, have been restricted. The majority of the world's population has been impacted to some degree (IOM, 2020).

The demographic effects of the pandemic are being felt across all three of the key demographic processes of fertility, mortality and migration. In some countries the pandemic is exacting a terrible mortality toll, while in others the impact appears to be very minor (Johns Hopkins University, 2020). International travel, and therefore international migration, has been severely curtailed (Connor, 2020) and rates of internal migration are also likely to be impacted, although the scale is unclear. Internal migration is strongly procyclical, suggesting that the impending recession is likely to dampen internal flows in advanced economies (Van der Gaag & Van Wissen, 2008). The effect on fertility is yet to become apparent, but the literature suggests a likely lowering of fertility for at least a short period (Matysiak et al. 2020).

This paper considers the possible effects of COVID-19 on Australia's demographic trends in coming years, focusing particularly on population ageing. We do so because ageing represents one of the major demographic trends of the twenty-first century and is a priority policy focus for government, with a multitude of implications for institutions, families and the Australian economy more broadly (Kendig et al. 2016; Parliamentary Budget Office, 2019; Treasury, 2015). Other researchers have examined the likely impacts of the pandemic on Australia's current and future fertility (McDonald, 2020), mortality (Kippen, 2020), internal migration (Bernard et al. 2020), and state and territory demographic change (Charles-Edwards et al. 2020).

Population forecasting is particularly hazardous at this time and there is considerable uncertainty about even the short-run future of the pandemic and its demographic consequences. It is possible there will be additional waves of COVID-19, like the Spanish flu a century ago (Martini et al. 2019). Government decisions about the re-opening of borders will greatly affect international migration trends, but these are hard to forecast at present. And there will undoubtedly be consequences which last well beyond the end of the pandemic which are extremely difficult to predict. We therefore present several scenarios which consist of possible trajectories for Australia's demography over the next two decades. Our aim is to describe a plausible range of demographic impacts, while acknowledging that our data and knowledge is limited in the present circumstances.

Population ageing is measured in terms of both numerical ageing (an increase in the absolute size of the older population) and structural ageing (an increase in

the proportion of the population in older age groups). We define the older population in two ways: first, in the traditional manner where it consists of those aged 65 years and above, and second, an alternative in which it comprises the population with 15 years or less of remaining life expectancy (Sanderson and Scherbov 2019; Wilson and Temple 2020). Following this introduction, we briefly describe the data, projection model, and scenario assumptions. The next section presents projection results for Australia's older population according to the various scenarios, before we finish with a final section of discussion and concluding remarks.

Data, methods, and scenarios

Population projections for Australia were prepared using a standard cohort-component model broken down by sex and single years of age, and based on the movement population accounts framework (Rees 1984). The projection equation for all age groups (except the newly-born) can be summarised as (Rees 1990):

$$P_{s,a+1}(t+1) = \frac{\left(1 - 1/2d_{s,a\to a+1} - 1/2e_{s,a\to a+1}\right)}{\left(1 + 1/2d_{s,a\to a+1} + 1/2e_{s,a\to a+1}\right)} P_{s,a}(t) + \frac{I_{s,a\to a+1}}{\left(1 + 1/2d_{s,a\to a+1} + 1/2e_{s,a\to a+1}\right)}$$

(1)

where P = population, d = death rate, e = emigration rate, I = immigration flow, t = point in time, s = sex, a = age group, $a \to a + 1$ = the period-cohort aged a at time t and a + 1 at time t + 1.

Time labels are omitted from rates in Eq. 1 to avoid clutter. Births are then projected as the product of age-specific fertility rates and female populations-at-risk and then divided into male and female births. Then the newly-born infant cohort is subject to mortality, immigration and emigration. The projection equation for infants can be expressed as:

$$P_{s,0}(t+1) = \frac{\left(B_s + I_{s,b\to 0}\right)}{\left(1 + 1/2d_{s,b\to 0} + 1/2e_{s,b\to 0}\right)}$$

(2)

where B = births, $b \to 0$ = the cohort which shifts from birth to age 0 over the t to t + 1 projection interval.

All input data were sourced from the Australian Bureau of Statistics (ABS), including census data obtained from the ABS TableBuilder Pro system (ABS, 2020a). The projections begin with a 30th June 2019 'jump-off' point and we present results out to 2041.

Projection scenarios were formulated primarily in terms of the 'headline' indicators of the Total Fertility Rate (TFR), annual Net Overseas Migration (NOM), and life expectancy at birth (e_0). Net overseas (or international) migration is defined as immigration minus emigration; the ABS defines immigration (emigration) as population movements into (out of) Australia in which a person stays in (out of) Australia for a total of at least 12 months within a 16 month period (ABS,

2020b). The immigration and emigration projections (from Eqs. 1 and 2) were adjusted during the running of the projection model to achieve consistency with the assumed levels of NOM.

We devised three plausible COVID-19 scenarios:

1. A **Shorter** impact scenario where economic and demographic trends bounce back strongly over 2–3 years,
2. A **Moderate** scenario where the effects are felt for about 5 years,
3. A **Longer** impact scenario with an extended economic depression of up to a decade.

Assumptions for the scenarios were formulated on the basis of judgement, given that existing fertility and migration forecasting models cannot effectively handle enormous shocks like a global pandemic, and were informed by multiple information sources. Among government publications, we examined the economic outlook of the Reserve Bank of Australia (RBA 2020) in its *Statement on Monetary Policy.* This includes three economic scenarios for Australia over the next few years: baseline – gradual recovery, slower recovery, and faster recovery. These scenarios are described by the RBA in terms of macroeconomic indicators, and do not include demographic details, but they provided a helpful starting point for our scenario thinking. We also paid careful attention to the short-term population forecasts included as part of the 2020 budget (Treasury 2020) which assume negative NOM for financial years 2020–21 and 2021–22.

We consulted the academic literature on the effects of recessions, large disease outbreaks, and major disasters on fertility and migration. Broadly, this suggests that in western countries both fertility and internal migration tend to be pro-cyclical, i.e. fertility reduces with economic recession (e.g. Matysiak et al. 2020; Sobotka et al. 2011) as does internal migration (e.g. van der Gaag & van Wissen, 2008; Alvarez-Contras et al. 2021). Our fertility assumptions were also influenced by recent data published by the ABS (2020c) and McDonald's (2020) projections on the future of fertility in Australia. Recent evidence from the 2008 global financial crisis shows worldwide international migration was impacted, with the greatest reductions in labour migration, and lesser impacts on humanitarian, family and other movements (Betts & Willekens, 2009). However, the impacts on NOM attributable to COVID-19 are likely to be much stronger and affect numerous visa classes due to the closure of national borders, and the timing of reopening of different sections of the economy (e.g. international students returning to tertiary education institutions). Finally, we canvassed the views of a select number of Australian migration and fertility experts through both an online survey and personal communications, receiving advice about possible trends in fertility and migration over the next few years (Charles-Edwards et al. 2020).

Quite different NOM trajectories were assumed for the three scenarios in the short-run, though a long-term value of 210,000 per annum was chosen for the long-run in all three scenarios. This assumes that the relatively high NOM gains of the last decade or so will eventually return. For fertility, we selected a

long-run TFR of 1.70, with different paths for fertility over the next few years. The TFR and NOM assumptions for the scenarios are illustrated in Fig. 1. Our mortality assumptions were based on an extrapolation of long-run mortality rate trends using Ediev's approach (2008). We therefore assumed no major impact from the pandemic on mortality given that the number of COVID-related deaths in Australia to date appears limited (ABS 2020d). These assumptions result in life expectancy for females increasing to 88.8 years by 2040–41, while for males it increases to 86.3 years.

In the **Shorter** scenario the impact of COVID-19 is short-lived and both the economy and demography recover rapidly. The TFR drops a little to 1.65, but then bounces back with recuperation of births postponed during the pandemic occurring between
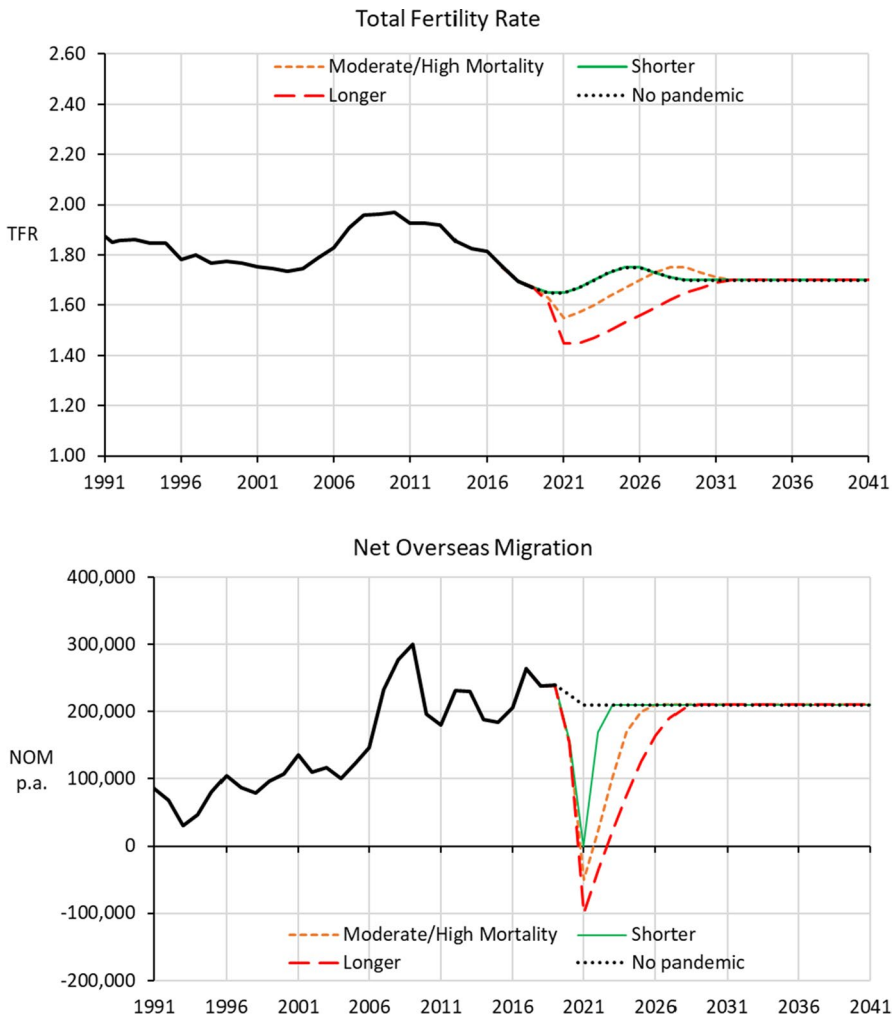

Fig. 1 TFR and annual NOM assumptions of each scenario. *Source*: ABS; authors' projections

2025 and 2031, with the long-run TFR of 1.70 assumed to apply from 2031 to 32 onwards. In this scenario NOM falls to zero in the 2020–21 financial year but bounces back quickly to 210,000 by 2022–23 due to government actions to attract international students and workers back to grow the economy.

In the **Moderate** scenario the economic and demographic impacts of COVID-19 last a few years. The TFR drops to 1.55 before recovering over the next few years and then experiencing some recuperation. NOM falls to − 50,000 in 2020–21, rises to 25,000 in 2021–22, and then continues to recover steadily over the next few years, reaching 200,000 by 2024–25 and then stabilising at 210,000 per annum from 2025 to 26. International students return gradually and the Australian border is opened progressively to more countries, and more migrants, over time.

The **Longer** scenario describes a more challenging set of circumstances. Overseas and Australian economies remain in deep recession for many years. COVID-19 proves hard to control. Unemployment remains high, international student numbers take a long time to recover, and the moribund state of the economy means demand for overseas workers is limited. The TFR plunges to 1.45 and takes many years to recover, eventually reaching the long-run value of 1.70. NOM drops to -75,000 in 2020–21, rising to -35,000 in 2021–22 with a slow recovery to 210,000 per annum by 2028–29.

We also created two additional scenarios for comparative purposes:

4. a **No Pandemic** scenario to illustrate Australia's likely demographic direction in the absence of the pandemic, and
5. a 'what-if?' **High Mortality** scenario to illustrate what would have happened if Australia had experienced excess mortality similar to that of the UK.

In the what-if? **High Mortality** scenario, we assumed that age- and sex-specific death rates had increased by the same proportional amount as those in England & Wales between 2019 and 2020. We obtained counts of deaths in England & Wales by sex and broad age group in 2019 and in 2020 up to 12th June from the Office for National Statistics website (ONS, 2020). We made the optimistic assumption of no further excess mortality in England & Wales after 12th June and 'nowcast' the remaining deaths for 2020 by borrowing deaths for the same period in 2019. We then estimated the ratios of deaths in 2020 to 2019 by sex and broad age group. With only small differences in population numbers between 2019 and 2020 these ratios provide approximations of the ratios in age-sex-specific death rates. These age-sex-specific ratios were multiplied by 2018–19 financial year death rates for Australia to estimate the 2019–20 set of pandemic death rates. The impact is assumed to be short-lived and after this one year of high mortality, death rates return to the mortality rates used in all other scenarios. The fertility and overseas migration assumptions were set to the values chosen for the Moderate scenario.

Results

The total projected population of Australia for selected years in the projection horizon is presented in Table 1. From an estimated population of 25.4 million in 2019, Australia's population is projected to grow to between 28.2 and 29.4 million by 2031 according to the three COVID scenarios, and then to between 31.6 and 33.0 million by 2041. The difference with the No Pandemic scenario by 2031, when all scenarios have converged in their assumptions, is 419,000 in the Shorter scenario, 933,000 in the Moderate scenario, and 1.68 million in the Longer scenario. By 2041 the differences are, respectively, 522,000, 1.11 million, and 1.97 million.

Projected population ageing is illustrated in Fig. 2. The upper graph shows that the population aged 65 + hardly varies between the scenarios. From 4.0 million in 2019, it is expected to grow to 6.7 million by 2041 according to all scenarios, with only tiny differences which are imperceptible on the graph. The population with 15 or fewer years of remaining life expectancy grows from 2.1 million in 2019 to 3.4 million by 2041 according to all scenarios, with the exception of the what-if High Mortality scenario where the 2019–20 fall in life expectancy temporarily increases this population by 212,000. This is because RLE < 15 years is, by definition, based on mortality conditions.

However, projected structural population ageing, depicted in the lower graph of Fig. 2, shows a moderate degree of variation between scenarios. The share of the total population aged 65 + of 15.9% in 2019 increases to 20.1% by 2041 in the No Pandemic scenario. In the other scenarios it increases to between 20.5% (Shorter) to 21.3% (Longer) by 2041. The proportion aged 65 + in the High Mortality scenario is close to those of the Moderate and Shorter scenarios due to the short-lived pandemic-related high mortality in this scenario. The share of the population with 15 or fewer years of remaining life expectancy (RLE < 15) similarly varies a little between scenarios. It increases from 8.3% in 2019 to 10.3% by 2041 in the No Pandemic scenario and, in the other scenarios, between 10.5% (Shorter) and 10.9% (Longer). In the High Mortality the value temporarily increases to 9.3% in 2019–20 compared to 8.4% in the other scenarios.

The immediate cause of the variation in structural ageing, but not numerical ageing, is shown in Fig. 3, which presents the projected age structure of Australia's population in 2031. As the graph shows, differences between scenarios are minimal

Table 1 The projected total population of Australia under the five scenarios, 2019–2041

Scenario	2019	2021	2026	2031	2041 Millions
Shorter	25.4	25.8	27.6	29.4	33.0
Moderate	25.4	25.7	27.1	28.9	32.4
Longer	25.4	25.7	26.5	28.2	31.6
No pandemic	25.4	26.1	28.0	29.8	33.5
High Mortality	25.4	25.7	27.1	28.9	32.5

Source: Authors' projections

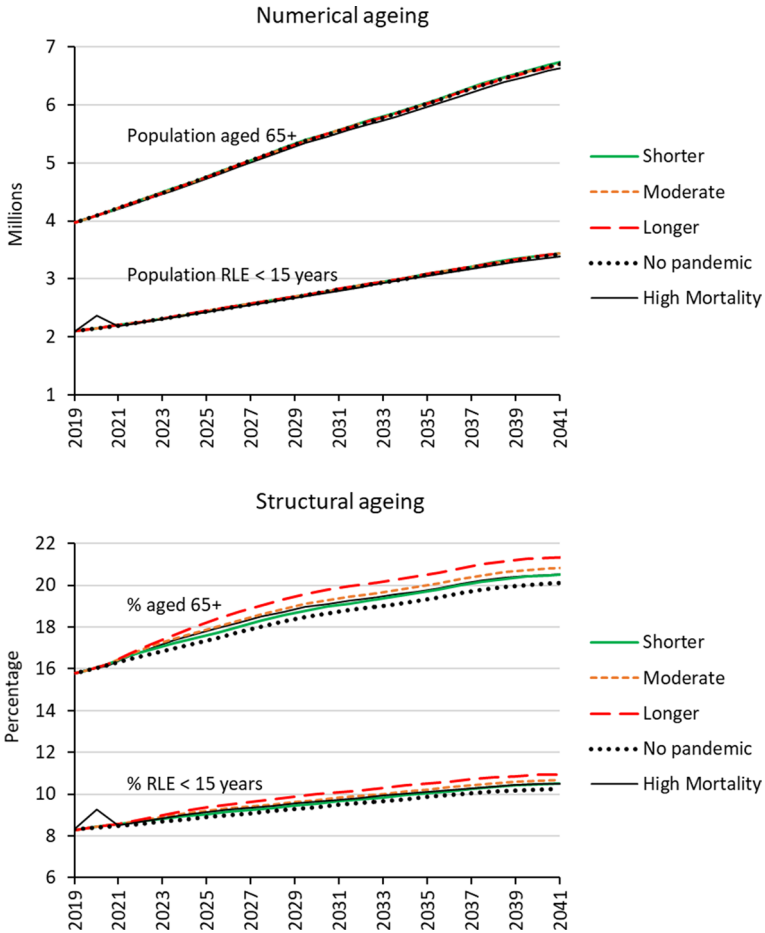## Numerical ageing

Structural ageing

Fig. 2 Projected numerical and structural ageing of Australia's population under the five scenarios, 2019–41. *Source*: authors' projections

above age 65, but quite large in the childhood ages up to about age 12 and in the younger adult ages where overseas migration is highest. Thus, the older population (measured either as those aged 65 + or RLE < 15 years) remains much the same while the total population varies between scenarios, and therefore the percentages in the older ages vary. Population age structure differences are created by variations in NOM assumptions for the younger adult ages and variations in both TFR and NOM assumptions for the childhood ages (with NOM affecting the size of the childbearing-age population).

The effect of the different scenarios on projected births and deaths is illustrated in Fig. 4. The lack of variation in the projected number of deaths between the first four scenarios is unsurprising because the alternative NOM assumptions make very little difference to the size of the population at older ages (where most deaths occur)
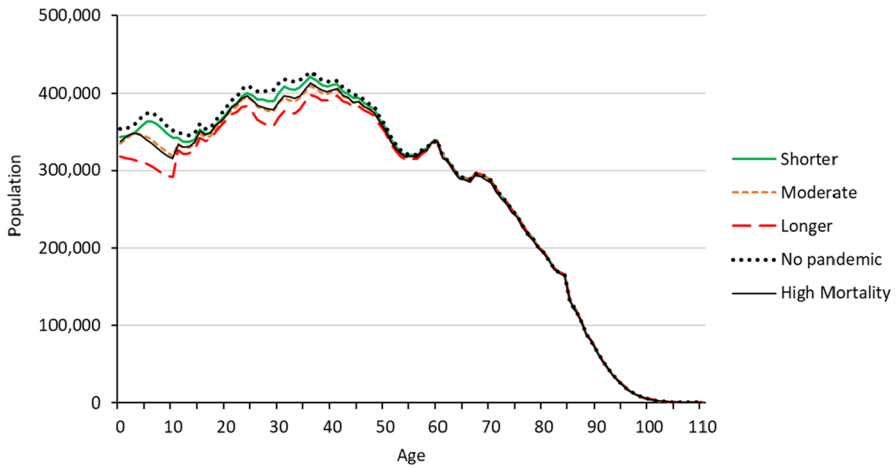
Fig. 3 The projected age structure of Australia's population under the five scenarios in 2031. *Source*: authors' projections
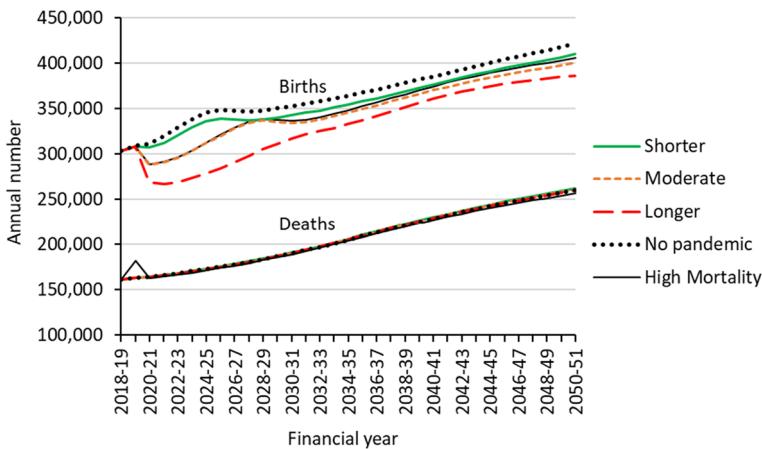

Fig. 4 Projected births and deaths under the five scenarios. *Source*: authors' projections

and the various TFR pathways make no difference over the projection horizon. In contrast, both the TFR and NOM variations across scenarios generate quite different outcomes for the projected number of births. Under the Longer scenario, for example, the annual number of births falls to a low of 19% below that in the No Pandemic scenario during the years 2022–25. Crucially, the numbers of births in the three COVID scenarios never recover to the levels of the No Pandemic scenario: the impact of the pandemic on births long outlasts the pandemic itself.

The impact of the High Mortality scenario on the number of deaths which would have occurred in 2019–20 under UK-like pandemic conditions is substantial. While 163,100 deaths are modelled for the first four scenarios, the High Mortality scenario

results in 182,500 deaths in 2019–20, which equates to 19,400 excess deaths (12% higher than 'expected'). In subsequent years the numbers of deaths projected in the High Mortality scenario are marginally lower than in the other scenarios.

Discussion and concluding remarks

One of the key demographic challenges facing Australian policy makers is ensuring the successful adaptation of the economy, institutions and broader society to continued population ageing. Until now, there has been limited evidence on the demographic consequences following the COVID-19 pandemic, including the effects on structural and numerical ageing. At the onset of the outbreak in early 2020, Piggott (2020) queried: "How will Australia's age structure change in the future? Will COVID-19 make any difference to it?" (Piggott, 2020). The pathway through which population ageing (both structural and numerical) may be impacted by COVID-19 is through changes to the key demographic processes of fertility, mortality and migration.

In this paper we have sought to outline the impact of possible changes to underlying demographic parameters attributable to COVID-19 on the number and relative size of the older Australian population. Overall, we find by 2041, COVID-19 would reduce the total population by between 522,000 (Shorter scenario) to 1.97 million people (Longer scenario). However, in terms of numerical ageing, the total number of older Australians (aged 65 and over) barely shifts under any of these scenarios. This finding is not unexpected, given the young age structure of migrants to Australia, and thus limited change in the older population through this pathway. Relative to other countries, impacts on mortality at older ages have also been small. By reducing the rejuvenating impact of immigration on age structure, and the possible fall in fertility arising due to COVID-19, we do, however, observe some increase in structural ageing. By 2041, we projected about 20.1% of the population to be aged over 65 in a No Pandemic scenario, relative to between 20.5% (Shorter) to 21.3% (Longer) in pandemic conditions. It is important to recall that under all scenarios, NOM returns to levels in excess of 200,000 per annum. Structural ageing would be considerably higher should NOM not return to this level. Much of this will depend not only on cyclical responses due to international and domestic macroeconomic conditions, but also due to decisions made by Australian policy makers regarding long-term levels of NOM. Prior to COVID-19, both major political parties were strongly supportive of high levels of immigration (Betts & Birrell, 2019).

Our modelling also provides evidence of the efficacy of the Australian response in reducing excess mortality due to COVID-19. In a senate enquiry into the Australian Government's response to COVID-19 during May, the Australian Chief Medical Officer suggested approximately 14,000 deaths had been avoided due to border

closures, social distancing and the broader public health response (McCauley, 2020). Our modelling indicates, that over the full 2019–20 financial year, if Australia had followed the example of England & Wales, an excess of 19,400 deaths may have occurred in 2019–20. This is a very significant figure and 12% higher than the No Pandemic scenario. To place this figure in context, in 2018 Australia's leading cause of death was Ischaemic heart disease, accounting for 17,533 deaths (ABS, 2019). The influenza outbreak (the 'Spanish flu') in Australia one century ago, accounted for between 15,000 and 16,000 deaths during 1919 (Curson & McCracken, 2006), making the annual death count of that year about 30% higher than it would otherwise have been.

By the early October 2020, 897 deaths attributable to COVID-19 had been reported (Department of Health, 2020). However, the full impact of the pandemic on deaths in Australia is yet to be revealed with some preliminary evidence suggesting the possibility of unaccounted COVID-19 deaths due to attribution to other causes (Bennett, 2020). Moreover, the shutdown and broader public health response may have generated negative externalities impacting morbidity and mortality. As raised by Bennett (2020) "Has the deferral of elective surgeries affected the death rate? Has there been a death toll associated with people being discouraged from visiting clinics or hospitals for other illnesses? Have the stresses of lockdown and financial uncertainty led to a rise in domestic violence or suicide?".

Our analysis has considered the impact of COVID-19 on population ageing, with the impact being minimal on numerical ageing and moderate on structural ageing. However, at the individual level, older Australians have been at an elevated risk of COVID-19 infection and mortality. As of early October 2020, approximately 22% of all COVID-19 cases have been attributed to people aged 60 and over, with this same group accounting for almost 98% of COVID-19 deaths (authors calculations from Department of Health, 2020). The pandemic is likely to have had a considerable impact on individual ageing experience of older Australians. For example, concerns have arisen about delayed presentation and treatment of non-COVID-19 conditions, postponement of elective surgeries and increased risk of symptoms of depression and anxiety (Holt et al. 2020). The United Nations has highlighted that with lockdowns and reduced care, elder abuse may be increasing (United Nations, 2020).

The broader macroeconomic impacts of COVID-19 on the Australian labour market have had a deleterious impact on mature age workers (Temple & McDonald, 2020). As the economic ramifications of the pandemic play out of the next few years, the superannuation balances of retirees may also be impacted. The ongoing consequences of COVID-19 for older Australians requires detailed analyses to support their wellbeing. Indeed, the current Royal Commission into Aged Care Quality and Safety has issued a call for submissions on the impact of COVID-19 "to understand the impact of the pandemic upon older Australians, their families and their carers in aged care facilities and receiving home care" (Royal Commission into Aged Care Quality & Safety, 2020). Ensuring that older Australians are supported through this critical COVID-19 recovery period will support the Government's policy aim of ensuring successful adaptation to population ageing.

Of course, our study contains a number of limitations. The most obvious one is the huge amount of uncertainty surrounding the future of the COVID-19 pandemic and its impacts on Australia's economy and demography. Much depends on global efforts to reduce infections, the timing and effectiveness of a vaccine, the length and depth of recession, and political responses to the situation. Our scenarios represent merely *possible futures* and certainly not forecasts with any degree of certainty. To enable comparisons of alternative effects of the pandemic between scenarios, we selected long-run assumptions which are identical. Many other scenario assumptions could have been chosen. It is entirely plausible, of course, that NOM does not return to the 200,000 + annual gains of recent years. At the same time, we cannot entirely dismiss higher levels of NOM either. A long-lasting recession may push Australia's fertility rate to record low levels, similar to those observed recently in many European countries. And the modest fertility recuperation we have assumed in some scenarios may fail to materialise. We also assumed no change in Australia's long-run mortality trajectory for most scenarios, though it is possible that some mortality effects of COVID-19 may only become apparent in the future. In addition, our selected age profiles of fertility, mortality, immigration and emigration, based on recent years of data, may also experience alterations due to the pandemic. In the context of all this uncertainty, the situation will need to be monitored closely and population projections updated regularly. Finally, we only examined the possible demographic impacts COVID-19 at the national level, but its effects will certainly be felt unevenly across the country. Further work will be required to examine the geographical variations in the demographic consequences of the pandemic.

Appendix

See Table 2.

Table 2 Immigration and emigration assumptions for selected years by scenario

	2019–20	2020–21	2021–22	2022–23	2023–24	2024–25	2030–31	2040–41
Immigration								
Moderate	450,000	25,000	150,000	300,000	425,000	475,000	525,505	580,484
Shorter	450,000	50,000	400,000	500,000	505,000	510,050	541,428	598,074
Longer	450,000	5,000	15,000	100,000	200,000	300,000	510,050	563,413
No Pandemic	552,090	557,611	563,187	568,819	574,507	580,252	615,950	680,392
Emigration								
Moderate	295,900	75,000	125,000	200,000	255,000	275,000	315,505	370,484
Shorter	295,900	50,000	230,000	290,000	295,000	300,050	331,428	388,074
Longer	295,900	105,000	50,000	80,000	125,000	175,000	300,050	353,413
No pandemic	327,090	347,611	353,187	358,819	364,507	370,252	405,950	470,392

Source: Authors' projections

Compliance with ethical standards

Conflict of interest None declared.

Ethics approval This project has been granted ethics approval by the University of Queensland (#2020001044).

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