PEOPLE AND PLACE

THE NEW INTERGENERATIONAL REPORT'S POPULATION PROJECTION AND THE UNCERTAINTY OF AUSTRALIA'S DEMOGRAPHIC FUTURE

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Recently it was announced that the population projection to be included as part of the next Intergenerational Report places Australia's population at a little over 35 million by 2049. Much media discussion has followed this announcement, a great deal of it concentrating on how the nation should plan for this coming population growth. A number of commentators, at least implicitly, appear to accept the projection as the true population of Australia at mid-century. This paper argues that the size of Australia's population in 40 years time is in fact subject to considerable uncertainty. It provides some indications of the magnitude of this uncertainty, outlines reasons why it exists, and recommends the use of probabilistic methods for future projections.

INTRODUCTION

In a recent speech on population ageing the federal Treasurer, Wayne Swan, released some details of the population projection to be included as part of the forthcoming third *Intergenerational Report*.[1] The part of the speech given considerable prominence in media reports was the projected population of a little over 35 million for Australia by 2049. This represents a significant upward revision from the 2007 *Intergenerational Report's* projection of 28.5 million by 2047 and an approximate doubling of projected population growth. It follows a similarly considerable upward revision to projections of Australia's population produced by the Australian Bureau of Statistics (ABS) last year.[2]

The 35 million figure generated a significant amount of media commentary and debate.[3] Questions asked included:

- How will the transport infrastructure of our capital cities cope with much larger populations?
- How will we supply homes and industry with enough water and power?
- Will there be severe housing shortages and an affordability crisis?
- Will our living standards decline?
- Do we need to plan new cities?
- Is Australia over-populated?
- What will be the environmental implications of a much larger population?

These are all important issues. But one important question seems to have been given little attention: how likely is this new projection? Many commentators—perhaps inadvertently—gave the impression that a population of 35 million by 2049 is a foregone conclusion, and that Australia is somehow locked into a demographic trajectory towards this figure. It is not. There is a great deal of uncertainty about the demographic future, especially 40 years out. In the next two sections this paper provides some indication of the magnitude of this uncertainty and outlines reasons why it exists. The purpose is not to criticise the *Intergenerational Report's* population projection per se, nor the interpretation of it by commentators. Instead, the paper argues for demographers to re-think the way population projections are prepared and presented in order to communicate their inherent uncertainty clearly. As the paper explains, high and low variant projections are unhelpful; the best approach is to switch to probabilistic population forecasting.

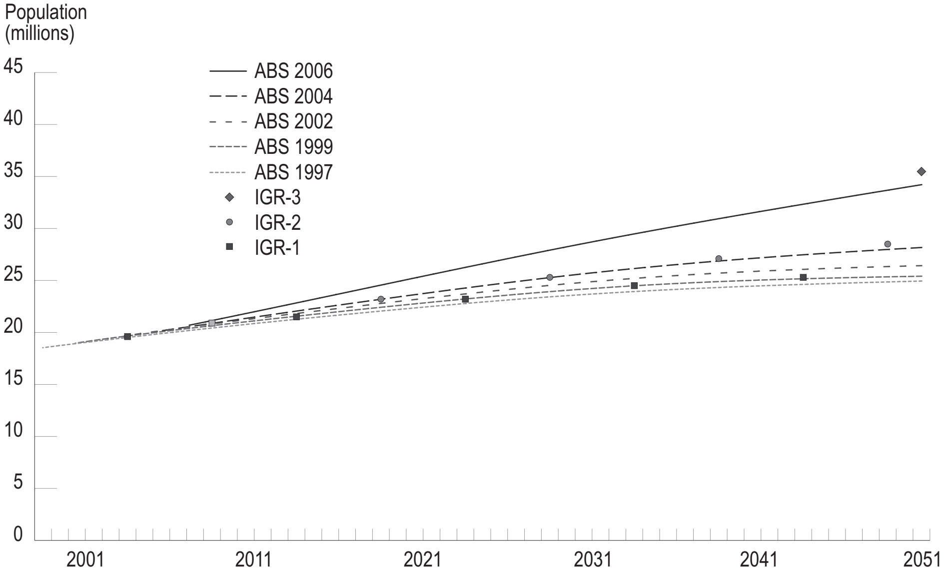
Before proceeding, a brief note on terminology is required. Many demographers are careful to emphasise that they produce population projections, not forecasts. A population projection may be defined as a quantitative statement about the future based on certain assumptions about the drivers of population change. Strictly, projections are always correct unless there are calculation errors. A forecast is a projection which is deemed to describe the most likely future. However, because projections are generally interpreted as forecasts this paper uses the term 'projection error' to describe how good (or bad) a projection was at forecasting the future. It is defined as the value of a middle-variant projection minus the Estimated Resident Population (ERP).

HOW MUCH UNCERTAINTY IS THERE?

As an introduction to demographic uncertainty it is instructive to examine how population futures predicted for Australia over the last decade or so have changed over time. Figure 1 shows the total population of Australia as predicted for the first half of this century by the three Intergenerational Reports and the five most recent ABS projections. Views of Australia's demographic future have clearly changed quite dramatically, and appear to be strongly influenced by demographic trends over the years immediately prior to the preparation of each projection. This is particularly the case for net overseas migration assumptions which have followed the upwards trend of published net overseas migration figures over the last 15 years.

The projections in Figure 1 cannot yet be assessed for accuracy except in the short-term. It is possible, however, to go back to earlier projections to examine how accurate these were, and to use their errors as an approximate guide to the magnitude of errors which may eventuate in the future. Figure 2 shows the percentage errors of previous ABS projections of Australia's population by projection horizon (the length of time from the launch year of the projections). As is generally the case with population projections, the further into the future

Figure 1: Australia's total population in the first half of the 21st century according to the three *Intergenerational Report* projections and the five most recent ABS projections

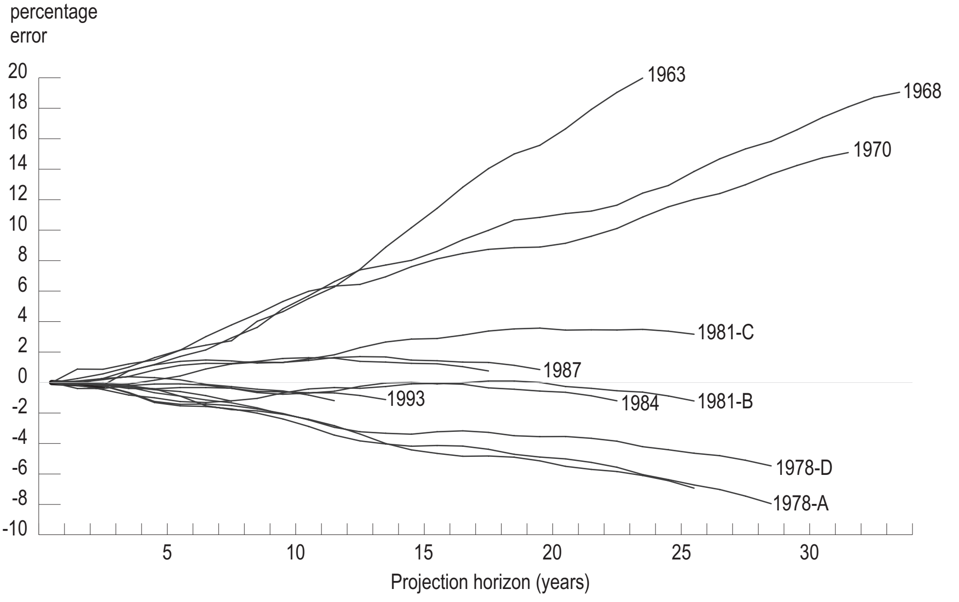


Sources: Middle series from various ABS Population Projections publications and *Intergenerational Reports*.
Notes: ABS-XXXX refers to the ABS population projection starting at year XXXX; IGR-Y refers to the Yth *Intergenerational Report*.

they extend, the greater the range of error. Although there are no projections in the graph which cover the 40-year period of the *Intergenerational Report*, it is not difficult to see that after such a period the range of error would be quite considerable.

Of course, future errors are not guaranteed to resemble those of the past. Some of the projections in Figure 2 were produced during the baby boom when fertility was expected to remain high (those beginning in 1963, 1968 and 1970). Fertility subsequently declined, resulting in large projection errors. It might be thought that in an era of lower and controlled fertility the populations of western countries could be projected with greater accuracy than in the 1960s and 1970s. This may not be the case. The recent upturn in fertility and the huge rise in net overseas migration were not predicted by most demographers (including the present author) even a few years ago. Although imperfect, past errors are a cogent reminder of the difficulties of forecasting future demographic behaviour and a useful guide to future errors.

Figure 2: Errors in past ABS projections of Australia's total population by projection horizon



Sources: Calculated from middle series in various ABS Population Projections volumes and estimated resident populations from ABS Population by Age and Sex, Australian States and Territories, 2007, catalogue no. 3201.0.

Notes: Labels on the graph refer to the launch year of the projections and, where relevant, the series. For example, 1981-B refers to Series B starting in 1981. Percentage error in any year t = (Projection(t) — ERP(t)) / ERP(t) x100%. Positive errors indicate projections that turned out to be too high; negative errors indicate projections which were too low. The projection starting in 1984, for example, turned out to be fairly good at predicting Australia's total population being only about 1 per cent too low 22 years out (in 2006). For the 1960s and 1970s projections adjustments have been made for discrepancies between the persons-present concept of population used in the 1960s and 1970s projections and the usually-resident population concept embodied in the estimated resident population (ERP) against which the projections have been judged in calculating percentage error. Where there was no obvious middle series projection the two series that came closest to a middle series were chosen.

While Figures 1 and 2 provide rough guides to demographic uncertainty, a more sophisticated approach is to incorporate the distribution of past errors into probabilistic population projections.[4] Probabilistic projections involve generating thousands of cohort-component projections by combining alternative fertility, mortality and migration trajectories. These trajectories are generated by statistical models informed by past projection errors. The results are typically presented as fan diagrams which display the likelihood of the future population lying within a certain range. Probabilistic projections overcome two major problems with traditional high and low variants:

- They indicate the likelihood of the population lying within each predictive interval. This is consistent with the principles and approaches in many engineering and planning projects which are based around risk and probability.
- They are statistically consistent over time and between variables. Traditional high-low ranges are inconsistent and misleading in that the range is potentially very wide for some demographic variables (such as total population) and implausibly small for others (such as the old age dependency ratio).

How much uncertainty is indicated by probabilistic population projections for Australia? Few attempts have been made to generate probabilistic population projections for Australia and those that do exist were produced with 2002 and 2004 launch years[5] and require updating. However, an approximate probabilistic population projection may be obtained by applying the Wilson and Bell predictive intervals to the new *Intergenerational Report* projection. Following standard practice in the probabilistic projections literature, these predictive intervals were constructed from a combination of past errors, time series models and expert judgement. Forty years into the projection horizon, the 95 per cent predictive interval for Australia's total population was estimated to range from 81 per cent to 121 per cent of the point projection. Applied to the new *Intergenerational Report* projection for 2049, this would imply a 95 per cent predictive interval of roughly 29 to 43 million.

Another approximate probabilistic projection can be calculated for comparison. It makes use of a short-cut probabilistic model developed as part of a major international research project by a team of demographers who evaluated United Nations population projections for the world, major world regions and individual countries, including Australia.[6] They created a statistical model to represent the likely range of uncertainty in the total populations of individual countries. Details of the model are available elsewhere,[7] but essentially it generates a set of predictive intervals, calibrated on past United Nations population projection errors, which may be used with current population projections. Applied to the new *Intergenerational Report* projection for 2049, the model suggests a 95 per cent predictive interval of about 27 to 46 million.[8] The wider interval is probably due to slightly greater error in UN projections compared to those of the ABS.

Of course, probabilistic predictive intervals are themselves estimates and will vary depending on the methods used to construct them and the projections to which they are applied. If they are calibrated to past projection errors they are based on the assumption that future errors will be similar to those of the past—which they may not be. Probabilistic projections are not a panacea for the difficulties of predicting future population. Predictive intervals are indicative only, but far better than high and low variants for the reasons mentioned above. Whether the 95 per cent predictive interval ranges from 29 to 43 million, from 27 to 46 million, or something similar, is less important than the point that Australia's total population by mid-century could lie within a fairly wide range. It would be beneficial for planning purposes to communicate this uncertainty to users by calculating probabilistic projections.

WHY IS THERE UNCERTAINTY?

What are the sources of all this uncertainty about Australia's demographic future? Why can't demographers produce population projections with greater accuracy? The literature[9] explains that greater accuracy is hampered by a number of factors, the most important of which are:

- imperfect data on the demographic past and present
- a limited understanding of demographic processes, and
- major events which are largely unpredictable.

Imperfect data on the demographic past can affect the accuracy of population projections by misrepresenting demographic trends. This is particularly the case where demographic events are measured indirectly. Concerns about the quality of net overseas migration estimates in the early 2000s[10] prompted the ABS to change its method for estimating net overseas migration. This was implemented from the middle of 2006.[11] The unofficial one-year overlap of the two methods for the 2005–06 financial year reveals significantly higher net overseas migration estimates from the new method.[12] An important test of this new method will come when the 2011 census-based ERP is calculated and compared with the ERP rolled forward from 2006 accounting for births, deaths and net overseas migration.

Other demographic components of change may also suffer from slight inaccuracies. Fertility and mortality data may be subject to errors. The difference between birth registrations in Australia and the number of births recorded in perinatal data sets is worrying. Perinatal data suggest higher fertility than registration data, a gentler decline in fertility over the 1990s as well as a greater increase more recently.[13] In 2006, the most recent year for which perinatal statistics are available at the time of writing, 280,078 live births occurred in Australia according to the perinatal data[14] while there were only 265,949 birth registrations.[15] Even allowing for registration delays, this is a concerning difference. In addition, population projections may be based on incorrect starting populations, especially when they begin in a non-census year for which the ERP is revised following the next census.

Probably a greater source of population projection error derives from a limited understanding—and therefore limited ability to predict—fertility, mortality and migration trends. Just a few years ago fertility appeared to be on a downward course, with many demographers predicting long-run total fertility rates of 1.7 or 1.6, or even lower. Few expected fertility to suddenly change tack and rise to approach replacement level. Much work remains to be done to produce better fertility predictions, though recent research by demographers McDonald and Kippen at the Australian National University is making headway in this area.[16] Life expectancy projections of the 1970s assumed no change in the future, based on the temporary plateau in life expectancy trends in the 1960s. Subsequent life expectancy projections have proved to be under-predictions.[17]

The broad direction of net overseas migration has proved an equally difficult projection challenge. Few demographers predicted the huge increase in temporary migration which Australia has experienced in recent years. The latest projections envisage that the current high levels of net overseas migration will continue, implying continued high levels of temporary net overseas migration and thus considerable growth in Australia's temporary population. This is debatable. The cyclical nature of migration is even more complex to predict than its overall trend and is largely beyond the current state of demographic knowledge. Many of the predictor variables in any model of overseas migration would probably be just as difficult to project as migration itself.

Related to the limited understanding of demographic processes are those major, sometimes sudden and often unpredictable, events which produce seismic shifts in demographic parameters and throw population projections off course. These include significant policy and legislative changes, technological advances, wars and other refugee-generating events, recessions and global financial crises. Some of these are not foreseen even a few months in advance, let alone several decades. The increase in Australia's Migration Program over the last decade provides a good example.[18] The Migration Program intake has more than doubled since the beginning of this decade, something which was not widely predicted ten years ago.

Together, the above sources of error make population projections a hazardous business. Despite many decades of progress in population modelling, significant improvements in projection accuracy remain elusive.

CONCLUSIONS

The third *Intergenerational Report* views Australia as following a high population growth trajectory over the next 40 years, with the nation's population totalling a little over 35 million by 2049. History cautions against placing too much confidence in this projection, or indeed any population projection for several decades into the future. Projections will almost always be wide of the mark to some extent because of the factors mentioned earlier, such as inaccurate historical data, limited understanding of demographic processes, policy changes and significant global events which are impossible to predict far ahead.

To what extent can demographers be blamed for inaccurate projections? Keyfitz argued in 1981 that: 'Demographers can no more be held responsible for inaccuracy in population forecasting 20 years ahead than geologists, meteorologists or economists when they fail to announce earthquakes, cold winters, or depressions 20 years ahead. What we can be held responsible for is warning one another and our public what the error of our estimates is likely to be'.[19] The methodology of national and state/territory probabilistic population projections is now sufficiently developed to provide such a warning. It would be of great benefit, therefore, if future projections of Australia's demographic outlook were expressed not in terms of point projections, but as probabilistic ranges.

Acknowledgement

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References

1 W. Swan, ‘The population challenge and Australia’s future’, speech to launch the Australia Institute for Population Ageing Research, Sydney, 18 September 2009 <www.treasurer.gov.au/DisplayDocs.aspx?doc=speeches/2009/025.htm&pageID=005&min=wms&Year=&DocType=1>, accessed 7 November 2009

2 *Population Projections, Australia, 2006 to 2101*, Catalogue no. 3222.0, ABS, Canberra, 2008

3 Examples of the media commentary include: A. Sinodinos, ‘The more of us the merrier’, *The Australian*, 24 September 2009, p. 12; Editorial, ‘Populate and prosper’, *The Australian*, 24 October 2009, p. 15; S. Lunn, ‘The shape of a big country’, *The Australian*, 31 October 2009, p. 2; B. Salt, ‘One big happy family’, *The Australian*, 31 October 2009, p. 11.

4 N. Keilman, D. Q. Pham and A. Hetland, ‘Why population forecasts should be probabilistic—illustrated by the case of Norway’, *Demographic Research*, vol. 6, article 15 <www.demographic-research.org> 2002

5 T. Wilson and M. Bell, ‘Australia’s uncertain demographic future’, *Demographic Research*, vol. 11 article 8, 2004 <www.demographic-research.org>; R. J. Hyndman and H. Booth, ‘Stochastic population forecasts using functional data models for mortality, fertility and migration’, *International Journal of Forecasting*, vol. 24, no. 3, 2008, pp. 323–342

6 National Research Council, *Beyond Six Billion*, National Academy Press, Washington DC, 2000

7 National Research Council, ‘Estimating expected errors from past errors’, Appendix F in ibid., pp. 326–348

8 The model’s parameters for Australia’s total population were reported for projection horizons of 10, 30 and 50 years. They were 0.045, 0.175 and 0.351 respectively. Polynomial interpolation was used to estimate a parameter of 0.25725 for a 40-year horizon. To give the 95 per cent upper bounds the point population projection is multiplied by $e^{\text{parameter}}$; the 95 per cent lower bounds are calculated by multiplying the point projection by $e^{\text{parameter}}$.

9 Examples are: N. Keilman, D. Q. Pham and A. Hetland, ‘Norway’s uncertain demographic future’, *Social and Economic Studies 105*, Statistics Norway, Oslo, 2001; J. de Beer, ‘Dealing with uncertainty in population forecasting’, working paper, Statistics Netherlands, 2000.

10 P. McDonald, S. Khoo and R. Kippen, ‘Alternative net migration estimates for Australia: exploding the myth of a rapid increase in numbers’, *People and Place*, vol. 11, no. 3, 2003, pp. 23–36

11 ‘Improved methods for estimating net overseas migration’, information paper, Catalogue no. 3107.0.55.003, ABS, Canberra, 2006

12 See page 16 of ‘Statistical implications of improved methods for estimating net overseas migration’, Information paper, Catalogue no. 3107.0.55.005, ABS, Canberra, 2006.

13 See section 2.3 of R. Lattimore and C. Pobke, ‘Recent trends in Australian fertility’, Productivity Commission Staff Working Paper, Canberra, Productivity Commission, 2008.

14 Australian Institute of Health and Welfare (AIHW), *Australia’s Mothers and Babies 2006*, AIHW National Perinatal Statistics Unit, Sydney, 2008 <www.npsu.unsw.edu.au/NPSUweb.nsf/resources/AMB_2008/$file/ps22.pdf>, accessed 30 November 2009

15 Recent fertility data are available in *Births, Australia, 2008*, Catalogue no. 3301.0, ABS, Canberra, 2009.

16 P. McDonald and R. Kippen, ‘The projection of births: a new approach’, paper presented at the Australian Population Association conference, Alice Springs, 30 June to 3 July 2008

17 T. Wilson, ‘The forecast accuracy of Australian Bureau of Statistics national population projections’, *Journal of Population Research*, vol. 24, no. 1, pp. 91–117

18 Fact Sheet 1—Immigration: the Background, Canberra, Department of Immigration and Citizenship, 2009 <www.immi.gov.au/media/fact-sheets/01backgd_01.htm>, accessed 7 November 2009

19 N. Keyfitz, ‘The limits of population forecasting’, *Population and Development Review*, vol. 7, no. 4, 1981, pp. 579–593