The future of Australia's Indigenous population

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Abstract

Existing projections of Australia's Indigenous population suffer from a number of limitations: problematic input data, unsatisfactory projection model design, and poor forecast performance. The aim of this study was to create a new model for projecting the Indigenous population which better represents the demographic processes at work, and which makes use of a newly available data source on identification change. A new projection model is presented which explicitly incorporates identification change, and mixed (Indigenous/non-Indigenous) partnering and childbearing. It is a composite static-dynamic model which takes a multistate form where data allow. The model was used to produce projections for the 2011-61 period. Rapid growth of the Indigenous is expected, with population momentum, identification change, and mixed partnering and childbearing shown to contribute more to growth than above-replacement fertility and increasing life expectancy. The future growth of Australia's Indigenous population is thus intimately connected to its interaction with the non-Indigenous population.

Key words

Indigenous; population projections; multistate; Australia; mixed partnering; identification change

1. Introduction

The Indigenous population of Australia consists of its Aboriginal and Torres Strait Islander peoples. Aboriginal people are estimated to have settled the Australian continent approximately 50,000 years ago (Rasmussen et al. 2011) whilst the Torres Strait Islanders, who originate from the islands located between mainland Queensland and Papua New Guinea, are believed to have arrived around 3,000 years ago (David et al. 2004). At the time of first European settlement in the late eighteenth century, the Indigenous population is estimated to have numbered between 770,000 and 1.1 million (Williams 2013). Newly-introduced diseases and settler violence then decimated the population through both very high mortality and suppressed fertility (Gray 1985; Smith et al. 2008). By the beginning of the twentieth century the census (albeit affected by significant coverage deficiencies) counted fewer than 100,000 Indigenous people, and it took until the 1970s for significant Indigenous population growth to be recorded (Ross 2002).

In data published by the Australian Bureau of Statistics (ABS) the Indigenous population is defined by self-identification. Since 1981 the standard census question has been 'Is this person of Aboriginal or Torres Strait Islander origin?' (Ross 1999; see Figure 1), and those who mark the 'yes' box are counted as Indigenous in official statistics. Unlike in some other countries' official statistics there is no opportunity to identify simultaneously as Indigenous and other ethnicities or origins, or report a mixed identity, though the Australian census form does permit individuals to report both Aboriginal and Torres Strait Islander origins. Mixed or part-Indigenous categories are usually excluded from contemporary discussions of Indigenous issues in Australia, and in most circumstances such descriptions would be considered offensive. This paper uses official ABS data and therefore classifies the population either as Indigenous or non-Indigenous. Critiques of official statistical classifications of Indigenous peoples can be found in Taylor (2009), Kukutai and Taylor (2012), and Kukutai and Walter (2015).

[Figure 1 here]

The most recent Estimated Resident Population (ERP), based on the 2011 Census and adjusted for census undercount, suggests that Australia's Indigenous population totalled 670,000 in 2011 (ABS 2013a). This is considerably more than the 517,000 estimated for 2006 on the basis of that year's census (ABS 2008), and equates to an annual average growth rate of 5.2% for 2006-11. This is clearly phenomenally high growth.

But the Indigenous population is not just a rapidly growing population; it is a rapidly growing and highly disadvantaged population. It is substantially more deprived than the Australian population as whole according to almost any socio-economic indicator one might choose. For

example, life expectancy at birth is about a decade lower than the Australian population as a whole; the prevalence of smoking is 2.6 times that of the non-Indigenous population; the unemployment rate for Indigenous persons aged 15 to 64 is about 4 times greater than that of non-Indigenous persons; and the imprisonment rate of Indigenous people is 13 times that of the non-Indigenous population (AIHW 2015). Addressing this disadvantage is a high political priority, and currently most attention is given to a set of 'Closing the Gap' targets agreed by national and state/territory (Australian Government 2008; COAG 2014). These comprise seven specific aims: 'closing the life expectancy gap within a generation (by 2031); halving the gap in mortality rates for Indigenous children under five within a decade (by 2018); ensuring all Indigenous four year olds in remote communities have access to early childhood education within five years (by 2013); halving the gap for Indigenous students in reading, writing and numeracy within a decade (by 2018); halving the gap for Indigenous people aged 20-24 in Year 12 or equivalent attainment rates (by 2020); halving the gap in employment outcomes between Indigenous and non-Indigenous Australians within a decade (by 2018)' (COAG Reform Council 2014 p. 5); and closing the gap in school attendance rates by the end of 2018 (COAG 2014).

Indigenous population data, and projections specifically, form an important component of the wider set of statistics necessary to monitor the progress of efforts to meet these targets. Projections can provide clues as to whether set targets are likely to be achieved on the basis of probable future demographic trends, and, if necessary, prompt thinking about what policy changes might be required to remedy the situation, or even what adjustments might have to be made to targets. In the context of high population growth rates, projections also play an important role as short-term population estimates, which are commonly used as denominators for a large number of indicators. ERPs for the Indigenous population are only produced for census years (those ending in 1 and 6) because data limitations preclude more regular estimates, and there is usually a considerable lag between the reference date of these ERPs and their publication. Until a new ERP is available, projections provide the only 'up-to-date' populations.

Previous Indigenous population projections in Australia have tended to suffer from one or more shortcomings. These include problematic input data, unsatisfactory projection model design, and poor forecast accuracy. Existing data for Indigenous projections, particularly on births and deaths, have long been affected by both coverage and quality limitations (Kinfu and Taylor 2005; Wilson and Barnes 2007; Johnstone 2011). In addition, until recently there were no data at all on intercensal identification change – defined as a change in an individual's reported Indigenous status from one census to the next. However, estimates of identification change can now be extracted from the recently released Australian Census Longitudinal Database (ACLD) which contains a sample of linked 2006 and 2011 census records (ABS 2013b). The introduction of this dataset therefore

provides an opportunity to produce projections of the Indigenous population which are informed more by directly observed data, and less on dubious indirect estimation techniques and guesswork, than in the past.

A second major shortcoming of existing Indigenous projections is the use of models which do not represent Indigenous population dynamics particularly well. Simplified models were used, to a large extent, because of data limitations. Most existing models do not incorporate identification change, or the consequences of mixed Indigenous/non-Indigenous partnering on childbearing and thus the Indigenous status of infants. Section 2 provides a review and critique of existing approaches to the modelling of Indigenous and ethnic minority populations.

A third problem is closely related to both data limitations and unsatisfactory models: many projections of the Indigenous population to date have turned out to be remarkably unsuccessful in predicting the ERP at the next census just five years later (Wilson and Taylor 2015). In the context of uncertainty surrounding both ERPs and projections it is not really appropriate to discuss 'forecast error' as such, but large discrepancies between projections and subsequently published ERPs are undesirable.

This paper reports on efforts to improve the methods for projecting Australia's Indigenous population specifically, and at the same time contribute to the international literature on modelling socially constructed population sub-groups more generally. It presents a new projection model which incorporates interaction between the Indigenous and non-Indigenous populations in the form of identification change, and mixed partnering and childbearing. Significantly, it explicitly models several partnership categories in order to capture the changing extent of mixed partnering and its influence on the projected number of Indigenous births. Using the results of the model, the paper seeks to answer the questions 'How much will Australia's Indigenous population grow over the next 50 years?' and 'What demographic factors will drive that growth?'

Following this introduction, the paper continues in section 2 by summarising existing methods for producing projections of Indigenous and ethnic minority populations. The new projection model is described in section 3, while input data and projection assumptions are the focus of section 4. Projection results and commentary are provided in the following section, before section 6 summarises the main findings and their implications.

2. Modelling Indigenous and ethnic minority populations

Population projection models for socially constructed populations, such as Indigenous or ethnic minority groups, usually have some form of cohort-component model at their core, but they are more complex than those for the population as a whole. Three aspects of their greater complexity are highlighted here. First, there is a larger state space of the model due to the existence of two or

more population groups rather than just one (the total population). Initial populations, base period data and projection assumptions for fertility, mortality, migration and other components are required for all groups. Second, people in self-identified population groups may change the way they report their identity over time (e.g. Simpson 2014; Biddle and Crawford 2015), requiring projection models to include identification change as an additional demographic component of change. In some countries, such as New Zealand and the US, the census permits individuals to report membership of more than one ethnicity or origin group, or a mixed category. Models must be able to handle these classifications too. Related to this is a third modelling challenge: how newly-born babies should be classified when mixed partnering occurs – defined as marriage or de facto partnering between people of different ethnic or Indigenous status groups (also described in the literature as intermarriage, exogamy, and inter-ethnic union formation).

Identification change

In the literature on Indigenous and ethnic group projection modelling, identification change tends to be (i) excluded, (ii) incorporated via net rates or numbers, or (iii) modelled with directional change rates as part of a multi-state model. In many modelling applications the first of these approaches has been taken: identification change is excluded, sometimes as a result of negligible amounts of it being recorded, and sometimes due to a lack of data, or a lack of usable data. For example, the lack of sufficiently reliable data was the reason why Rees et al. (2012) assumed no identification change in their ethnic group population projections for the UK. Similarly, the US Census Bureau projections of the US population by race and Hispanic origin assume ethnic identity remains inalterable throughout a person's life (USCB 2014), and in its most recent Indigenous population projections, the ABS also chose not to incorporate identification change in any of their projection variants (ABS 2014).

However, in some previous sets of ABS Indigenous projections, it was incorporated indirectly in the form of 'unexplained growth' applied as state- and sex-specific 'net rates' in the high scenario (ABS 2004). Statistics Canada (2015) and Statistics New Zealand (2015) also use net rates in some or all variants of their Aboriginal and ethnic group projections. Unfortunately the application of net rates means that people are added to the population without them being drawn from an origin population at risk, an issue best known from work illustrating the problems caused by net migration rates in cohort-component models (Rogers 1990). Net rates are not only conceptually problematic, but in practical terms they have the potential to generate high growth and implausible age structures (Wilson 2016).

Instead, it is more conceptually satisfactory and empirically sensible to take a multi-state approach and model directional identification change, e.g. movements from non-Indigenous to

Indigenous, and from Indigenous to non-Indigenous. Multiplying occurrence/exposure rates by an 'origin' population at risk permits the volume of identification change in each direction to be a function of the size of the source population. Individuals are moved from one category to another, and do not appear out of nowhere. Doing so also avoids the embarrassment of projecting 'negative populations'. This approach does increase complexity, however, because the model must include all population groups and not just focus on one minority group of interest. In the case of Australia's Indigenous population, it requires the joint modelling of Indigenous and non-Indigenous populations, rather than just the Indigenous population alone (ABS 2014). It also requires projection assumptions for a demographic component for which there are few studies on either the empirical characteristics or the processes at work (but the recent contributions by Biddle and Crawford 2015, and O'Donnell and Raymer 2015 are welcome exceptions).

There are currently very few examples of Indigenous status or ethnic group population projections which incorporate directional identification change. One exception is Wilson's (2009) multi-state projection model for Australia's Northern Territory, which, although it includes identification change in the model, was forced to use very rudimentary age-sex-invariant identification change assumptions due to data limitations. In other countries, there has similarly been little work on projections which include permit directional identification change. The model proposed by Rees (2002 p. 34) which includes multi-state probabilities of changing ethnic group is one of the few exceptions.

Mixed partnering and childbearing

Methods for assigning ethnicity to newly-born infants born of mixed parentage have received a little more attention in the literature. The most basic approach is to give the baby the same Indigenous status or ethnic group as its mother. It excludes any influence of the father's identification, however, and is unlikely to reflect reality. The approach becomes less impractical if the ethnic group distribution of babies is embodied in adjusted age-specific fertility rates. These adjusted age-specific fertility rates are calculated as births of babies reported as being in group x (irrespective of their mother's ethnic group) divided by females in group x (Storkey 2002). While conceptually awkward, it is a simple and practical way round the issue embodied in some models.

Alternatively, the ethnicity of babies born to mothers of any one ethnic group may be distributed across several ethnic groups, thus indirectly accounting for the influence of fathers' ethnicities. This approach usually involves obtaining data from a recent census on the reported ethnic identities of young children cross-classified by those of their mothers. Probabilities of babies belonging to ethnic group x given a mother of ethnic group y are then calculated and, during the projection calculations, births to mothers of each ethnic group are distributed to ethnic groups

according to these probabilities. Examples of this approach can be seen in ethnic group estimates prepared for England by Large and Ghosh (2006), UK ethnic group projections produced by Rees et al. (2012) and Wilson's (2009) Indigenous status projections for the Northern Territory of Australia.

The ABS assume all babies born to mixed couples are Indigenous (ABS 2015), which is somewhat at odds with its self-identification approach on the census form, and with empirical evidence from the census (Gray 1998; Kinfu and Taylor 2005; Wilson 2009). Births to Indigenous mothers are projected in the standard way using age-specific fertility rates, with all projected births being counted as Indigenous. Births to couples formed of non-Indigenous women and Indigenous men are projected with age-specific paternity rates applied to the numbers of Indigenous men, and again all these births are counted as Indigenous (ABS 2014). Statistics New Zealand use fertility and paternity rates in a similar manner (Statistics New Zealand 2015).

None of the above approaches accounts for the changing ethnic patterns of partnering and childbearing. As the ethnic composition of populations change, the ethnic composition of partnering also changes. So if, for example, minority group x increases its share of the population while majority group y declines in share, then it is quite likely for more partnering between the groups to occur (Hollmann and Kingkade 2005). This in turn will alter the ethnic distribution of babies born to mothers of both x and y groups. To incorporate these changes in projection models, it is necessary to model partnering (Murphy 2002). Unfortunately this is not simple. Dividing the population into partnered and unpartnered categories increases the model's state space further. If a fully multi-state model is constructed, fertility, mortality, migration, identification change and partnering assumptions are required for all population categories. Assumptions are also necessary to allocate ethnicity to babies born to every ethnic combination of couples and unpartnered women. It also requires the two-sex issue of matching the number of partnered males and females to be addressed.

3. The new model

The new model for creating population projections by Indigenous status explicitly incorporates identification change and interaction between the Indigenous and non-Indigenous populations in partnering and childbearing. A key contribution of the new model is the direct connection between Indigenous births and the extent of mixed partnering.

The model was designed as far as possible to match the available data sources in Australia, and it therefore combines both dynamic and static elements. Where data allow, the model takes the form of a multistate cohort-component model, in which the flows from one demographic state to another, such as from Indigenous to non-Indigenous identification, are modelled explicitly. The model is organised within the movement population accounting framework set out by Rees (1984),

and the population accounts table specific to the new model is shown in Table 1. The population accounting equation for the Indigenous population, for example, is therefore:

$$P_{Ind}(t+5) = P_{Ind}(t) - D_{Ind} - E_{Ind} - C_{Ind,NI} + C_{NI,Ind} + I_{Ind} \quad [1]$$

where the terms are as defined in the notes beneath Table 1. For the purposes of this study the model has been operationalised in an Excel/VBA program with the calculations set out in an iterative scheme. It uses five year age groups and five year projection intervals and has a maximum projection horizon of 50 years.

[Table 1 here]

Deaths, emigration, and identification change are all projected in a conventional manner with occurrence/exposure rates and person-years at risk (Willekens and Drewe 1984). For example, period-cohort deaths are projected by multiplying death rates by an approximation of the person-years at risk:

$$D_{i,s,c}(t, t+5) = \tfrac{5}{2}\, d_{i,s,c} \left(P_{i,s,c}(t) + P_{i,s,c}(t+5) \right) \quad [2]$$

where i refers to Indigenous status, s to sex, c to cohort and d to death rate. Immigration is projected directly as immigration flows, which are determined as a projection assumption. The projection program allows identification change and overseas migration flows to be adjusted to match user-defined net identification change and net overseas migration totals if required.

To enable the projection of mixed childbearing, six partnership categories of women are distinguished amongst the population aged 15 and above. 'Partnered' in this case refers to both legal and de facto opposite-sex marriages. The categories are: (i) Indigenous women partnered with Indigenous men, (ii) Indigenous women partnered with non-Indigenous men, (iii) non-Indigenous women partnered with Indigenous men, (iv) non-Indigenous women partnered with non-Indigenous men, together with (v) unpartnered Indigenous women and (vi) unpartnered non-Indigenous women. However, data on flows between these partnership categories are unavailable, forcing a simpler static modelling approach to be employed.

A two-stage approach to projecting the number of women by these six categories is taken. In stage one, the numbers of adults by Indigenous status who are partnered and unpartnered is projected using partnership proportions, in a manner similar to headship rate and propensity household models (Wilson 2013). For example, the population of Indigenous status i, sex s and aged a and partnership status m is an assumed proportion z of the population of Indigenous status i, sex s and age a:

$$P_{m,i,s,a}(t+5) = z_{m,i,s,a}(t+5)\ P_{i,s,a}(t+5). \quad [3]$$

The numbers of partnered males and females tends to differ (the well-known two-sex problem), and it is dealt with here by adjusting the values so they both sum to the mean of the original male and female partnered totals.

In stage two, projections of partnered adults by age and Indigenous status, and age and Indigenous status of partner, are created, as depicted by the matrix in Figure 2. These projections are calculated by taking an initial partnership matrix and then applying iterative proportional fitting so that the rows and columns sum to the projections by Indigenous status, age and sex calculated in stage one. The latter form the marginal totals of the matrix, shown in Figure 2 as the shaded arrays. The default initial partnership matrix is based on 2011 Census data, though the projection program permits alternative assumptions to be specified in terms of the proportion of Indigenous adults with non-Indigenous partners.

[Figure 2 here]

The fitted partnership matrix permits the projected female populations in the first four partnership categories to be obtained. Age-specific female populations are calculated as the row sums of each quadrant of the matrix; for example, the number of Indigenous women aged 15-19 partnered with non-Indigenous men is the sum of the top row in the upper-right quadrant. The numbers of unpartnered Indigenous women and unpartnered non-Indigenous women are already known from stage one of the partnership calculations. Age-specific fertility rates are then applied to female populations in the six partnership categories:

$$B_{m,a}(t, t+5) = \tfrac{5}{2} f_{m,a} \left(P_{f,m,a}(t) + P_{f,m,a}(t+5) \right) \quad [4]$$

where B refers to births, m partnership status, f age-partnership-specific fertility rates, and subscript f female populations.

Births are then summed over age of mother and allocated between Indigenous and non-Indigenous categories. Babies from each of the six partnership categories are distributed between Indigenous and non-Indigenous categories using assumed Indigenous status proportions. Thus:

$$B_i(t, t+5) = \sum_m \left(s_{m,i}\, B_m(t, t+5) \right) \quad [5]$$

where $s_{m,i}$ denotes the proportion of babies born to mothers of partnership category m who take Indigenous status i. For those partnership categories where both parents share the same Indigenous status, babies would normally always be given the same status as their parents, i.e. the proportion s for that Indigenous status category would be set to 1.0. For babies born of mixed parentage proportions will lie between 0 and 1, with values differing from 0.5 indicating inter-generational gain or loss for a particular Indigenous status. For example, a value of 0.9 Indigenous would result

in inter-generational gain for the Indigenous population because 90% of babies born to Indigenous/non-Indigenous couples would be Indigenous. Finally, Indigenous and non-Indigenous births are divided into males and females via sex ratios at birth.

4. Projection assumptions

The projection program requires assumptions to be formulated about the future of mortality, overseas migration, identification change, and proportions partnered, all by Indigenous status, together with assumptions about the extent of mixed partnering, fertility by partnership status of woman, and the Indigenous status of babies given the Indigenous status of parents. The selected assumptions are summarised in Table 2 and briefly explained below.

[Table 2 here]

Mortality, expressed in the form of life expectancy at birth, is projected to continue increasing for both Indigenous and non-Indigenous populations. Non-Indigenous mortality was projected using the extrapolative approach of Ediev (2008), proven to be highly accurate by Terblanche (2015). Indigenous mortality was projected by using the most recent ABS Indigenous life tables (ABS 2013c) and making assumptions about future age-sex-specific declines in mortality based on recent Indigenous mortality change. Unfortunately reliable time series of Indigenous mortality data are unavailable at the national level, but good quality data for the Northern Territory demonstrate little change in the Indigenous – non-Indigenous life expectancy gap since the mid-1960s (Wilson 2014). Indigenous life expectancy at birth assumptions were therefore adjusted slightly to increase at exactly the same rate as that of the non-Indigenous population. While this assumption of no improvement in the life expectancy gap between Indigenous and non-Indigenous populations may seem pessimistic, it does reflect recent trends (Australian Government 2016) and it also involves large absolute increases in Indigenous life expectancy.

Immigration and emigration flows are projected as separate migration flows in the model, but initial flows are adjusted so that they yield a specified annual net overseas migration total. Small Indigenous immigration and emigration flows were adjusted to give a zero net overseas migration total, whilst non-Indigenous flows were constrained to give an annual net overseas migration gain of 250,000 per year from 2016 onwards, which is close to the short-term forecasts published by the Department of Immigration and Border Protection (DIBP 2015). Recorded overseas migration data for 2011-14 were incorporated in to the non-Indigenous assumption for 2011-16.

Identification change rates were calculated from the Australian Census Longitudinal Dataset (ACLD), a 5% sample of individual 2006 Census records linked to 2011 Census records (Zhang

and Campbell 2012; ABS 2013b; Biddle and Crawford 2015). The ACLD represents the first available dataset of linked Australian census records and permits direct measurements of changes in reported Indigenous status between censuses to be calculated. However, the data are far from perfect. Because names and addresses on census forms are deleted by ABS following census data capture, linking had to be undertaken on the basis of variables common to both sets of records, inevitably resulting in some unmatched records and false links; second, one of the matching variables used in the linking process was Indigenous status, which probably results in some understatement of identification change; and third, the data are affected by sampling error. Despite these shortcomings, the ACLD provides the first direct measurements of Indigenous status change and represents a valuable addition to the data environment for preparing Indigenous population projections. Over the 2006-11 intercensal period more individuals switched from non-Indigenous to Indigenous than vice versa, with especially large changes in the childhood ages. The underlying reasons behind these changes in Australia are yet to be fully understood, though an analysis by ABS (2013d) found many children aged 5-14 being identified on the census form as Indigenous to be non-Indigenous (or not stated) five years earlier in the previous census. Many of these children were of mixed parentage, which hints at some uncertainty about the identification of these children when very young which is resolved when they are older. Studies from other countries suggest that other possible reasons for reported identification change include the increasing partnering of people from a wide variety of ancestries in large urban centres which encourages greater fluidity in identification, political and legal decisions which support Indigenous peoples, and increasing pride in Indigenous ancestry (Guimond et al. 2014). But in the absence of a robust understanding of the phenomenon in Australia, the 2006-11 identification change rates by age and sex were assumed to apply throughout the projection horizon.

Partnership proportions, describing the proportion of adult populations who are partnered, are assumed to remain at their 2011 Census values. Little change in the extent of partnering has been observed in recent years (Yap and Biddle 2012). However, the extent of mixed partnering is projected to increase. According to the 2011 Census 58% of Indigenous persons aged 15 and over in a registered or de facto marriage had a non-Indigenous partner. This represents about a 7 percentage point increase from 2001 (Heard et al. 2009; Biddle 2013). It is difficult to predict exactly how the levels of mixed partnering will change, but further increases seem likely. One of the key predictors of an Indigenous individual having a non-Indigenous partner is the proportion of the local population identifying as non-Indigenous (Heard et al. 2009; Biddle 2013). Thus, with strong Indigenous population growth in Australia's urban areas which contain mostly non-Indigenous populations (ABS 2013d), more mixed partnering would be the obvious consequence. It

has therefore been assumed that the proportion of partnered Indigenous adults with non-Indigenous partners will increase by three percentage points every five years.

It is assumed that the fertility of partnerships involving one or more Indigenous adults will decline while non-Indigenous fertility will remain constant at approximately the level of the last decade. Evidence on recent Indigenous fertility is unclear unfortunately. According to census data on children ever born the cohort fertility of Indigenous women has been gradually declining since the 1980s, although period birth registration data shows stability during the late 1990s (when the data became available) and early 2000s followed by fertility increases in recent years (ABS 2014 p. 19). The two trends are not necessarily contradictory, but both data sources suffer non-trivial coverage and accuracy problems (Johnstone 2011) and only limited reliance can be placed on them in considering the future of fertility. Drawing on the findings of Yap and Biddle (2012), who showed that Indigenous women with more education have fewer children, it is assumed that as Indigenous educational outcomes slowly improve, fertility will gradually fall. Non-Indigenous fertility has fluctuated relatively little in recent years and is assumed to remain unchanged.

The proportions of babies born to each of the six partnership categories of women identified as Indigenous are informed by 2011 Census data. All babies born to Indigenous women partnered with Indigenous men are assumed to be Indigenous; similarly all babies born to two non-Indigenous parents are assumed to share their parents' Indigenous status. Most babies born of mixed parentage are Indigenous (89%), and the same is the case for unpartnered Indigenous mothers (90%). A small proportion of births to unpartnered non-Indigenous women is assumed to be Indigenous (1%). Similar distributions of the Indigenous status of children by parentage were reported by Gray (1998) using 1996 Census data, suggesting some stability in these values over time. The 2011-based proportions are therefore held constant throughout the projection horizon.

5. The future growth of Australia's Indigenous population

Projections

Australia's Indigenous population is projected to increase from 670,000 in 2011 to 1.2 million by 2036 and 2.0 million by 2061. The non-Indigenous population is expected to increase from 21.7 million in 2011 to 43.0 million 50 years later. Although both populations are projected to experience high growth, the Indigenous growth rate is greater and results in the share of Australia's population identifying as Indigenous gradually rising from 3.0% to 4.4% over the course of the projection horizon. The author's Indigenous projections track a little above the medium series projections published recently by the ABS (2014), being 7% higher by 2026, the end of ABS's projection horizon.

The age structure of the Indigenous population is likely to remain young, as Figure 3 illustrates. The proportion of the population aged 65 years and above is anticipated to rise from just 3% in 2011 to 8% by 2036 and only 9% by 2061; the equivalent figures for the non-Indigenous population are 14%, 19% and 22%, which are still low relative to the degree of ageing projected for most other western populations (UN 2015). Numerical increases in the Indigenous population by age group will be greatest over the childhood and younger adult ages, whilst proportional increases will be highest in the upper half of the population pyramid. Compared to the ABS Indigenous projections (2014), the age profiles are similar in the adult age groups, but they are larger across ages 5-19. The reason is net identification change gains to the Indigenous population which are highest for the cohort aged 5-9 at the start of each projection interval and 10-14 at the end, and also relatively high for the two immediately adjacent cohorts. These childhood identification changes are part of the reason for the continued youth of the age profile. The ABS projections do not incorporate identification change.

[Figure 3 here]

Because of the assumption of zero net overseas migration for the Indigenous population, projected population growth can be summarised as natural increase plus net identification change. Projected Indigenous births and deaths, and identification change flows, are shown in Figure 4. With the rapid growth in Indigenous births, natural increase (the difference between the two solid lines in the graph) is projected to rise from 69,000 in 2011-16 to 152,000 by 2056-61. Net identification change gains (represented by the gap between the two dashed lines) are smaller than natural increase and diminish gradually over the course of the projection horizon, from 27,000 in 2011-16 to 15,000 by 2056-61. The immediate cause of the decline in these net gains is the more rapid growth of identification change losses to the non-Indigenous population. This, in turn, is the result of constant rates of identification change being applied to the faster growing Indigenous population – the 'origin' population at risk for identification changes from Indigenous to non-Indigenous.

[Figure 4 here]

The projected numbers of births in Figure 4 are the sum of Indigenous births from the six partnership categories of women listed earlier. The rapid growth of the Indigenous population and the assumed increase in mixed partnering generates large increases in the projected number of Indigenous adults with non-Indigenous partners (Indigenous women with non-Indigenous men, and

non-Indigenous women with Indigenous men). Among those in the childbearing ages of 15-49, the increase is from about 67,000 in 2011 to 153,000 by 2036 and 303,000 by 2061. The number of unpartnered Indigenous women also rises substantially, from 109,000 in 2011 to 285,000 by 2061. However, the number of Indigenous women partnered with Indigenous men increases only modestly and even begins to drop by the end of the projection horizon. It is the outcome of two offsetting trends: Indigenous population growth, but also a gradual decline in Indigenous-only partnering (implemented as an assumed increase in mixed partnering). In sum, the population at risk of giving birth to Indigenous babies will increase mostly from the substantial growth of Indigenous adults in mixed partnerships and the increasing numbers of unpartnered Indigenous women.

These projected changes in the partnership composition of the childbearing-age population result in an increasing share of Indigenous babies being born to non-Indigenous women. Of the 86,000 Indigenous babies born during 2011-16, 22,000 (26%) are borne by non-Indigenous women; by 2056-61 this is projected to have increased to 69,000 out of 206,000 Indigenous births (34%). The contribution of non-Indigenous women to Indigenous population growth through the birth of Indigenous babies is thereby substantial. By adding to the increasing number of births they also assist in maintaining the very young population age profile shown in Figure 3.

Drivers of Indigenous population growth

The projected components of change presented above are useful for determining the population accounts of a projection. But they do not provide much insight into the relative contributions of the assumed demographic rates on future population growth. In the case of Australia's Indigenous population, the demographic drivers of growth can be summarised as: rising life expectancy, above-replacement fertility, mixed partnering and childbearing, identification change, and a young age structure (momentum). There is no migration effect in this case because the main projection assumed no net overseas migration.

A simple approach was taken to determine the relative contributions of each of these drivers. For all but age structure, alternative projection variants were prepared which excluded just that one driver. For example, the contribution of identification change was established by running the projection program with all identification change rates set to zero and then comparing the resulting population with that of the main projection. The effect of age structure was established by determining the amount of population growth that would occur in the absence of all other factors, i.e. with just replacement fertility and unchanging life expectancy (Bongaarts and Bulatao 1999). All assumptions for the non-Indigenous population were left unchanged. An alternative approach would have been to remove the demographic drivers cumulatively, as proposed by Bongaarts and Bulatao (1999). Rees et al. (2013) applied this technique to their ethnic group population

projections for the UK. However, the interaction between the drivers in the case of Australia's Indigenous population is huge, leading to very different magnitudes of influence depending on the order in which the various factors are removed.

[Figure 5 here]

Figure 5 shows the impact of each of these drivers on projected Indigenous population growth over the course of the projection horizon. In many western countries, immigration gains and life expectancy increases are responsible for population growth (where it is occurring). Fertility is below replacement and, if there is much contribution from population momentum, it is often negative. The picture is clearly very different in this case. The key contributors to Indigenous population growth are its youthful age structure of the population, net identification change gains, and mixed partnering and childbearing. The effect of net identification change is actually greater than it appears from Figure 4. The net number of identification changes summed over the whole projection horizon is about 230,000, but the effect on the 2061 population shown in Figure 5 is greater, at about 340,000. The difference is due to the contribution net identification change makes to increasing the Indigenous population at risk of other demographic events which increase the population, such as giving birth. In sum, these projections indicate that interaction with the non-Indigenous population through identification change and mixed partnering will be responsible for roughly half the growth of Australia's Indigenous population over the 50 years to 2061.

For the purpose of this decomposition exercise the non-Indigenous projection assumptions were not varied. However, the amount of interaction between Indigenous and non-Indigenous populations is, of course, also influenced by the growth of the non-Indigenous population. This is the consequence of modelling multiple interacting populations. For example, the higher the growth of the non-Indigenous population, the greater the number of identification changes from non-Indigenous to Indigenous for any particular set of identification change rates. If somehow Australia's net overseas migration gains dropped sufficiently so that the non-Indigenous population grew by only half the amount in the main projection, then the 2061 Indigenous population total would be 0.2 million lower at 1.79 million. Similarly, higher non-Indigenous population growth would raise Indigenous population numbers above those presented here.

Alternative scenarios

Two alternative scenarios were run to determine the impact of other variables on the projections. The first focused on the outcome of fixing the amount of mixed partnering at its 2011 value of 58% of partnered Indigenous adults having non-Indigenous partners. The total projected population is

slightly lower than in the main projection, with the difference reaching 54,000 by 2061. Primarily it is due to fewer Indigenous births, with the number of Indigenous babies born in 2056-61 being 206,000 in the standard projection and 188,000 in this alternative scenario. The distribution of Indigenous births across the partnership categories is significantly changed, however, with a little over twice as many Indigenous births to Indigenous women partnered with Indigenous men, and substantially fewer births from mixed partnerships. The lower number of births from mixed partnerships reduces inter-generational gain to the Indigenous population given that about 90% of births in such partnerships are assumed to be Indigenous. There is also a minor flow-on effect to identification change, with the net identification gain in 2056-61 being 18,100 rather than 15,000 due mostly to a smaller source population for Indigenous to non-Indigenous changes. Age structure effects are, not surprisingly, concentrated at the bottom end of the population pyramid. By 2061 the projected Indigenous 0-14 year old population would be 544,000 rather than 582,000.

In the other alternative scenario, the Indigenous status distribution of babies was varied over the course of the projection horizon. For the three partnership categories of Indigenous women with non-Indigenous men, non-Indigenous women with Indigenous men, and unpartnered Indigenous women, the percentage of babies born Indigenous was reduced by 2 percentage points in every 5 year projection interval. The assumption underlying this scenario is that with increasing mixed partnering in the future, more parents in mixed partnerships will describe their babies as non-Indigenous. While it is extremely difficult to make a judgment about the likelihood of this scenario, it cannot be discounted. The outcome of this assumption is for the total projected population to be lower than in the main projection, with a difference of 110,000 evident by 2061. As would be expected, projected births are responsible for a substantial amount of the difference, with fewer Indigenous and more non-Indigenous births. Also contributing is net identification gain to the Indigenous population. Over the projection horizon, this decreases to a smaller extent over time than in the standard projection so that by 2056-61 it is 21,200 in this scenario compared to 15,000 in the main projection. This occurs because there is smaller source population for Indigenous to non-Indigenous changes, and a larger source population for non-Indigenous to Indigenous changes.

6. Conclusions

This paper has presented a new model for projecting Australia's population by Indigenous status, and used it to produce a new set of projections from 2011 to 2061. Significantly, the model explicitly handles identification change and partnering, with the latter allowing the amount of mixed partnering to vary, which in turn influences the Indigenous status composition of births. Decomposition of the projections revealed increasing life expectancy and above-replacement fertility to be relatively modest contributors to future Indigenous population growth; far more

important were the young age structure, identification change, and mixed partnering and childbearing. The projections thus demonstrate how the future size and age structure of Australia's Indigenous population are intimately connected to the non-Indigenous population.

The high population growth projected for the Indigenous population takes it past one million in the late 2020s and two million in the early 2060s according to these projections. It prompts the question 'Is there likely to be a larger Indigenous population in the next 50 years than in the era prior to European contact?' Unsurprisingly, there are no reliable statistics on the size of the Indigenous population before European settlement in the late eighteenth century. However, recent work by Williams (2013), based on archaeological radiocarbon data, estimates a peak population of roughly 1.2 million about 500 years ago. If this figure is correct, the projections indicate that Australia's Indigenous population will become the largest it has ever been by around the mid-2030s.

It is important to remember, of course, that population projections always have limitations. They reflect the outcome of a particular model and chosen input data. The jump-off populations are not precise figures obtained from a high-quality population register. They are estimates based on imperfect census counts. Base period data on fertility, mortality, migration, identification change and partnering are also not as reliable as those for the Australian population as a whole. Projection assumptions are therefore not as robust as one would like due to both data problems and an incomplete understanding of Indigenous demographic processes. It might be the case, for example, that as the Indigenous population achieves better educational outcomes, migration patterns will change: migration from remote areas to the large labour markets of the State capital cities may increase, as may emigration. With important contributions from identification change life expectancy may rise faster than assumed here. It has been shown that people reporting themselves as Indigenous who previously reported as non-Indigenous tend to be less disadvantaged (Biddle 2015). Greater efforts to improve Indigenous health might also assist in reducing the mortality gap.

Future work to support projections would usefully focus more on measuring and understanding identification change, mixed partnering, and the Indigenous status of mixed parentage babies. Ideally, this would be related to broader conceptual work theorising Australia's Indigenous demographic transition. In terms of modelling, further research into methods for handling partnering would be helpful, with fully multistate and microsimulation models and their demanding data requirements worthy of further exploration. In addition, the extension of the model presented here to a multiregional version must be a high priority. Not only are subnational projections crucial to planning and policy formulation, spatial variations in identification change and mixed partnering are considerable, and form an important dimension of national Indigenous demographic change.

Notes

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2. Detailed projection results are available from the author on request.

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Table 1 The movement population accounts table for any period-cohort

		State after move				Total
		Indigenous	Non-Indigenous	Overseas	Death	
State before move	Indigenous	R_{Ind}	$C_{Ind,NI}$	E_{Ind}	D_{Ind}	$P_{Ind}(t)$
	Non-Indigenous	$C_{NI,Ind}$	R_{NI}	E_{NI}	D_{NI}	$P_{NI}(t)$
	Overseas	I_{Ind}	I_{NI}	$\emptyset$	$\emptyset$	I
Total		$P_{Ind}(t+5)$	$P_{NI}(t+5)$	E	D	T

Source: adapted from Rees (1986, p. 136)

Notes: t = time; Ind = Indigenous; NI = Non-Indigenous; P = population; D = death; E = emigration; I = immigration; C = identification change; Ind,NI = change from Indigenous to non-Indigenous; R = accounting residual; T = grand total; Ø = not relevant. For newly-born infants, the number of births replaces the start-of-period population at time t.

Table 2: Summary of projection assumptions

Component	**Assumptions**
Mortality	Indigenous e_0: Females: 74.3 years in 2011-16 rising to 80.6 in 2056-61 Males: 69.8 years in 2011-16 rising to 78.5 in 2056-61 Non-Indigenous e_0: Females: 84.6 years in 2011-16 rising to 90.9 in 2056-61 Males: 80.3 years in 2011-16 rising to 89.1 in 2056-61
Overseas migration	Immigration numbers and emigration rates of 2006-11 constrained to net totals: Indigenous: net overseas migration of zero Non-Indigenous: net overseas migration of 250,000 per annum
Identification change	Rates of identification change during 2006-11 from Indigenous to non-Indigenous, and vice versa, held constant
Proportions partnered	Proportions partnered by Indigenous status and sex held constant from 2011 Census values
Mixed partnering	The percentage of partnered Indigenous adults with non-Indigenous partners: 58% in 2011 increasing to 88% by 2061
Fertility	TFRs by partnership status: (i) Indigenous women with Indigenous men: 3.50 in 2011-16; 3.20 in 2056-61 (ii) Indigenous women with non-Indigenous men: 2.50 in 2011-16; 2.28 in 2056-61 (iii) non-Indigenous women with Indigenous men: 3.00 in 2011-16; 2.74 in 2056-61 (iv) non-Indigenous women with non-Indigenous men: 2.00 held constant (v) unpartnered Indigenous women: 2.10 in 2011-16; 1.92 in 2056-61 (vi) unpartnered non-Indigenous women: 1.75 held constant
Indigenous status of babies	Proportion of babies who are Indigenous by parentage: (i) Indigenous women with Indigenous men: 100.0% (ii) Indigenous women with non-Indigenous men: 89.2% (iii) non-Indigenous women with Indigenous men: 88.7% (iv) non-Indigenous women with non-Indigenous men: 0.0% (v) unpartnered Indigenous women: 90.0% (vi) unpartnered non-Indigenous women: 1.0%

Is the person of Aboriginal or Torres Strait Islander origin?

• For persons of both Aboriginal and Torres Strait Islander origin, mark both 'Yes' boxes.

- No
- Yes, Aboriginal
- Yes, Torres Strait Islander

Figure 1: The ABS question on Indigenous status used since 1981
Source: ABS 1996 Census form

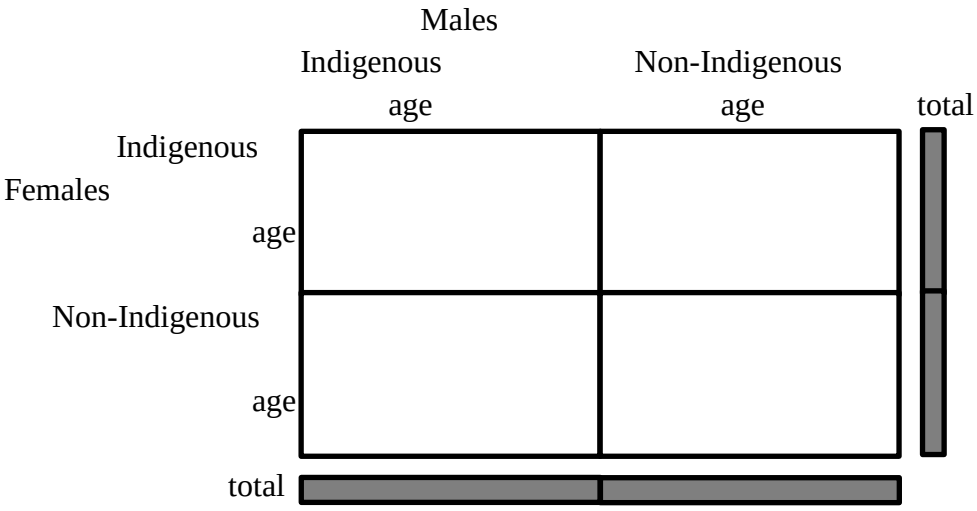

Figure 2: The partnership matrix of partnered adults by Indigenous status and age, and Indigenous status and age of partner

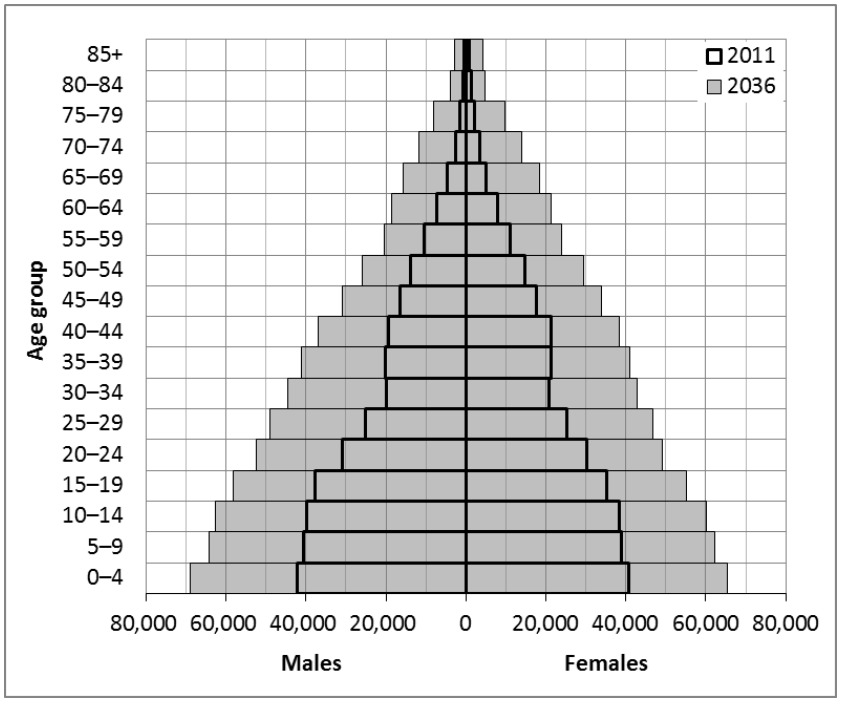

Figure 3 The age-sex structure of Australia's Indigenous population in 2011 (estimated) and 2036 (projected)
Source: ABS 2011 Estimated Resident Populations and author's projections

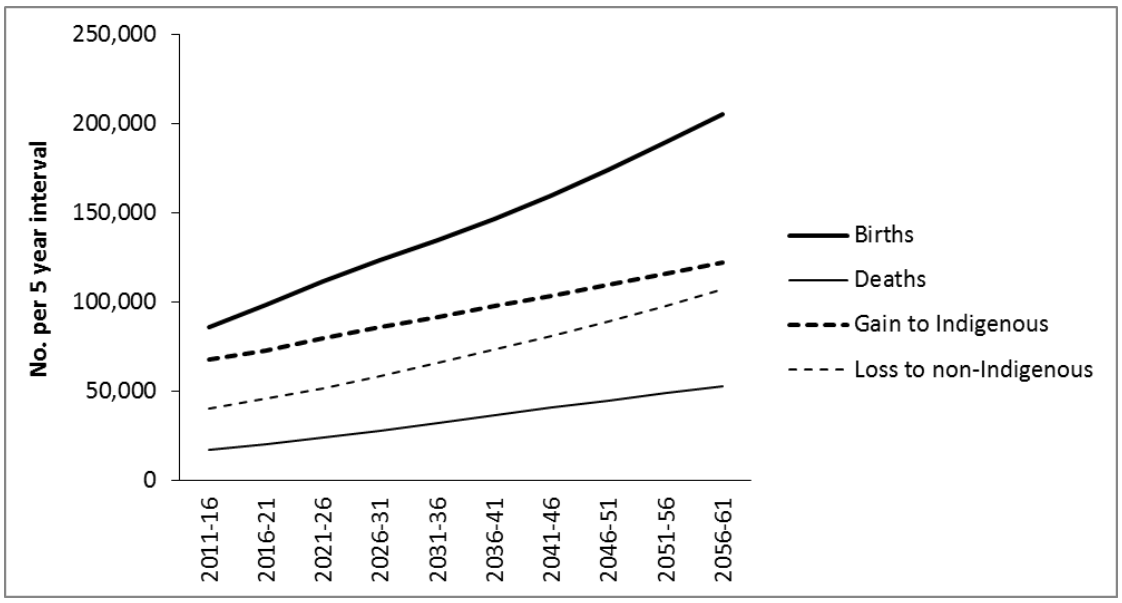

Figure 4: Projected Indigenous births, deaths and identification change
Source: author's projections

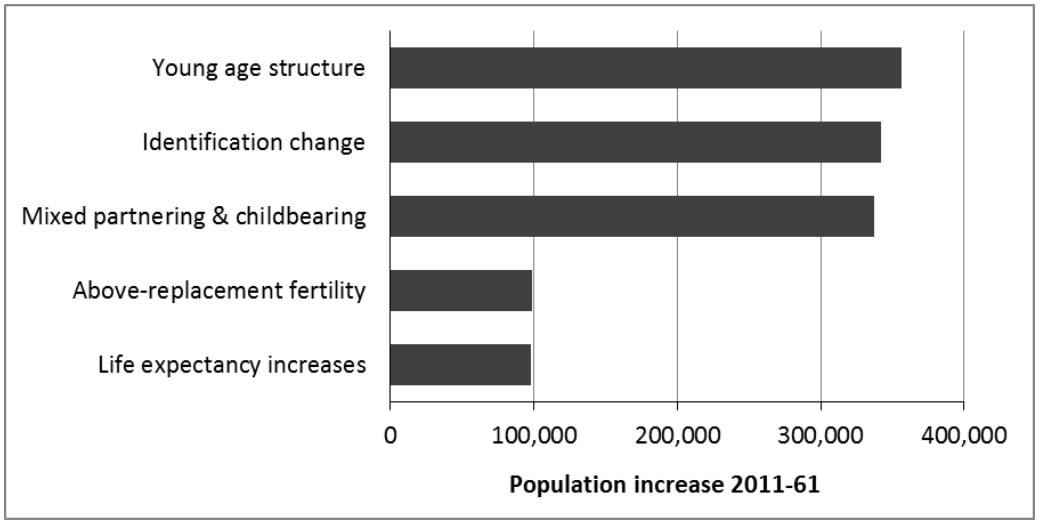

Figure 5: Effect of various demographic drivers on Indigenous population growth 2011-61
Source: author's projections
Note: the individual effects do not quite sum to the actual projected population increase because of interaction between the drivers