# Quantifying the demographic drivers of subnational population ageing: the case of Australia

Tom Wilson
Jeromey Temple

The University of Melbourne

**Extended abstract**

## 1. Introduction

It is widely acknowledged that almost all countries of the world are experiencing population ageing (UN 2017). Informed by the stable population model, the conventional wisdom in demography is that population ageing is primarily the result of fertility decline. However, this view has been challenged by a number of studies which indicate a dominant role for mortality improvement in more developed countries. Preston, Himes and Eggers (1989) introduced an innovative method which decomposes changes in mean age into those due to the births, survival and net migration of cohorts. In a study of the US population they estimated that about two-thirds of the increase in mean age between 1980 and 1985 was due to improved survival. Later, Preston and Stokes (2012) used the same approach to estimate that 82% of the mean age increase among the world's More Developed Countries between 2005 and 2010 was the result of improved survival. Murphy (2017) applied an extension of the method and showed how the ageing of European populations switched from being driven more by births to more by survival around the middle of the twentieth century.

These valuable studies improve our understanding of the sources of ageing in national populations. The unique contribution of this study is an examination of the drivers of population ageing at the *subnational* scale, focusing specifically on the case of Australia's states and territories. While some studies have considered the causes of subnational population ageing (e.g. Davies and James 2011; Denny 2018; Jackson and Felmingham 2002) they have not all quantified the demographic sources of ageing and none of those focusing on Australia has applied the Preston, Himes and Eggers cohort decomposition method. Specifically, this paper addresses the question 'What are demographic drivers of population ageing at the state and territory scale in Australia in the 21st century?' by applying the Preston, Himes and Eggers method. Australia represents an interesting case study of subnational ageing because its states and territories have experienced quite different demographic histories, especially with respect to migration.

## 2. Data and methods

A population is ageing if its mean age is increasing over time. The mean age of a population, $A$, may be calculated as:

$$A = \frac{\sum_a P_a x_a}{\sum_a P_a} \quad (1)$$

where $P$ denotes population, $a$ age group, and $x_a$ the exact age mid-point of age group $a$. Change in the mean age between times t and t+n may be written as the product of the age-specific population growth rate ($r$), the proportion of the population ($c$) in age group $a$, and the difference in age between the mid-point age of the age group and the population mean age, summed over all age groups:

$$\Delta A(t, t+n) = \sum_a (r_a(t, t+n)\, c_a(t, t+n)\, [x_a - A(t, t+n)]) \quad (2)$$

(Preston, Himes and Eggers 1989).

The age-specific growth rate in equation 2 can be decomposed into births, survival and net migration contributions. Note that the population of a specific age group at time $t$ can be expressed as the original number of births ($B$) of that cohort multiplied by the proportion ($p$) of the cohort surviving to age $a$ multiplied by a cohort net migration factor ($m$):

$$P_a(t) = B(t-a)\ p_a(t-a)\ m_a(t-a) \quad (3)$$

(Preston and Stokes 2012). The growth rate of the population at age $a$ between times t and t+1 can then be represented as:

$$r_a(t, t+n) = ln\frac{B(t-a+n)}{B(t-a)} + ln\frac{p_a(t-a+n)}{p_a(t-a)} + ln\frac{m_a(t-a+n)}{m_a(t-a)} \quad (4a)$$

or

$$r_a(t, t+n) = r_{a(B)}(t, t+n) + r_{a(p)}(t, t+n) + r_{a(m)}(t, t+n) \quad (4b)$$

The changes in mean age contributed by births, survival and net migration are therefore, respectively,

$$\Delta A_B(t, t+n) = \sum_a \left(r_{a(B)}(t, t+n)\, c_a(t, t+n)\, [x_a - A(t, t+n)]\right)$$

$$\Delta A_p(t, t+n) = \sum_a \left(r_{a(p)}(t, t+n)\, c_a(t, t+n)\, [x_a - A(t, t+n)]\right)$$

$$\Delta A_m(t, t+n) = \sum_a \left(r_{a(m)}(t, t+n)\, c_a(t, t+n)\, [x_a - A(t, t+n)]\right). \quad (5)$$

Due to data limitations it was not possible to divide net migration into internal and international components. The decomposition was undertaken using five year age groups (up to ages 100-104) and five year time intervals.

Input data consisted of population estimates, births, and deaths for Australia and the eight states and territories from 1901 to 2016. These were obtained from the Australian Bureau of Statistics (ABS), the Australian Demographic Databank, and the Human Mortality Database (HMD).

## 3. Preliminary results

Over the 2001-16 period, Australia's population increased in mean age from 36.8 to 38.7 years (+1.9 years). Amongst the states and territories mean age increases ranged from +1.5 years in Victoria (from 37.1 to 39.6 years) to +3.7 years in Tasmania (from 37.6 to 41.2 years). Preliminary results of the mean age increase decomposition are shown in Figure 1. For Australia overall the largest contributor to population ageing over the 2011-16 period was improved survival (contributing 69% of the mean age increase), followed by fertility (57%), with net migration mitigating ageing (-26%).

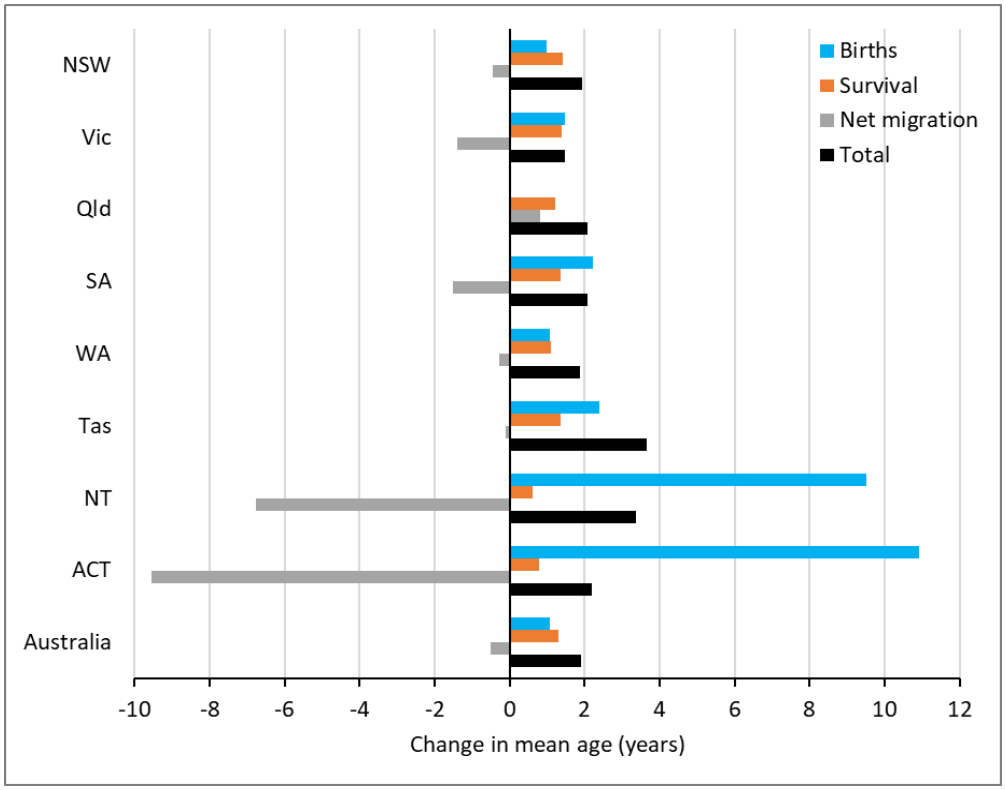


**Figure 1**: Contributions to increases in the mean age of the population, 2001-16, Australian states and territories

Note: NSW = New South Wales, Vic = Victoria, Qld = Queensland, SA = South Australia, WA = Western Australia, Tas = Tasmania, NT = Northern Territory, ACT = Australian Capital Territory

Amongst the states and territories there was huge variation in the demographic sources of population ageing, with only New South Wales coming close to the national pattern. The contribution of improved survival varied the least of the three components, but births and net migration varied considerably. In the two mainland territories, the Northern Territory and Australian Capital Territory, mean age increases were dominated by massive fertility effects which were to a large extent offset by rejuvenating migration effects. Queensland was the only state or

territory in which net migration made a positive contribution to the mean age increase and the only one in which births made almost no contribution at all.

## 4. Discussion and conclusion

This paper has confirmed that at the state and territory scale in Australia the sources of contemporary population ageing are highly varied in both relative importance and absolute values. It demonstrates that no inferences about subnational drivers of population ageing can be implied from a national level decomposition. In only 3 of the 8 states and territories was improved survival the largest contributor to ageing; in the remainder births played a dominant role.

The populations of the Northern Territory and Australian Capital Territory stand out because of the huge, but offsetting, ageing sources. They are both characterised by very high interstate migration flows which act to reduce population ageing. At the same time the rapid growth rate in births in the third quarter of the 20th Century (NT), and from the mid-20th century onwards (ACT), is contributing currently substantially to ageing in those territories. The contribution of net migration to increasing population ageing in Queensland may seem surprising at first. It has experienced high volumes of net migration gains for many decades. But it is the *change* in cohort net migration rates across age groups which affects ageing, and in Queensland older age groups have grown more from cohort net migration between 2001 and 2016 than younger age groups.

## References


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