Projection method for the Australian Capital Territory Statistical Local Areas (SLAs) and Census Collection Districts (CDs) - more details

The three-tiered approach outlined in Appendix I has been further disaggregated in this accompanying paper. Apart from the births formulae all equations apply to both sexes, so sex has not been denoted. "State" and "state-level" may refer to either State or Territory.

Step 1

This involved projecting the Australian Capital Territory population by age and sex, 2003 - 2009. The cohort component method used can be summarised in the formulae below:

x	->	age
max	->	highest age projected (100+ for State, 85+ for SLAs)
t	->	base year
P	->	population
F	->	fertility rate
f	->	females
B	->	births
Q	->	death probability
OM	->	net overseas migration
IM	->	net interstate migration
NM	->	net migration (SLA projections only)

In Step 1 the following refer to interstate migration; in Step 2 they refer to overseas + inter-SLA migration.

DEP	->	departures
ARR	->	arrivals
DEPRATE	->	per capita departure rate (donor state/SLA)
ARRRATE	->	per capita arrival rate (receiving states)

For ages 0 to maximum age - 1:

(i) $$P_{X+1}(t+1) = P_X(t) * [1-Q_X(t)] + (0.5 * OM_X(t)) * (1-(0.5 * Q_X(t))) + (0.5 * OM_{X+1}(t)) * (1-(0.5 * Q_{X+1}(t)))$$

(ii) $$P_{max}(t+1) = P_{max}(t) * [1-Q_{max}(t)] + P_{max-1}(t) * [1-Q_{max-1}(t)] +$$

$$OM_{max}(t) * (1-(0.5 * Q_{max}(t))) +$$

$$(0.5 * OM_{max-1}(t)) * (1-(0.5 * Q_{max-1}(t)))$$

Births were then calculated:

$$(iii) \quad B(t) = 0.5*[\sum_{x=15}^{49} (F_x(t)*P_{f,x}(t))+ \sum_{x=15}^{49} (F_x(t+1)*P_{f,x}(t+1))]$$

After constraining to projected State-level births, these were then used to calculate age 0 in the projected year:

$$(iv) \quad P_0(t+1)= B(t)*(1-Q_b(t)) + (0.5*OM_0(t)) * (1-(0.5*Q_0(t)))$$

Interstate migration was calculated by applying departure rates to the Australian Capital Territory population and arrival rates to the population of the remaining States and Territories (to obtain numbers departing other States to reside in the Australian Capital Territory). These rates were derived from 1996 and 2001 Census data and were held constant for the duration of the projection.

$$(v) \quad DEP_x(t+1) = P_x(t+1) * DEPRATE_x$$

$$(vi) \quad ARR_x(t+1) = P_x(t+1)^{Non\text{-}ACT} * ARRRATE_x$$

The resulting total arrivals and departures were then scaled to a predetermined total net interstate migration assumption. Finally, the arrivals and departures by age and sex were scaled to the new arrival and departure totals, then combined to give net age/sex interstate migration.

$$(vii) \quad IM_x(t+1) = ARR_x(t+1) - DEP_x(t+1)$$

Then add the interstate migration:

$$(viii) \quad P_x(t+1) = P_x(t+1) + IM_x(t+1)$$

To achieve coherent interstate migration figures projections are concurrently run for all States, Territories and Australia. After constraining of State age/sex population sum to the Australian-level, year t+1 then became the base for projecting the next year and the cycle was repeated until the final projection year was reached.

Step 2

This used the cohort component method to project all the Australian Capital Territory SLAs. The

formulae in Step 1 generally apply to the SLA projections, except that the upper age is 85+, fertility rates are by 5yr age of mother, migration arrival rates are not used and Net Migration (overseas + inter-SLA) was used instead of overseas and inter-SLA separately.

This slightly simpler approach to migration was warranted as the overseas component is negligible in most SLAs in comparison with inter-SLA migration. Furthermore an annual historical time-series only exists at the SLA level for net migration, any overseas/inter-SLA split must approximated using past Census data.

For ages 0 to maximum age - 1:

(ix) $$P_{x+1}(t+1) = P_x(t) * [1-Q_x(t)]$$

(x) $$P_{max}(t+1) = P_{max}(t) * [1-Q_{max}(t)] + P_{max-1}(t) * [1-Q_{max-1}(t)]$$

Births were then calculated:

(xi) $$B(t) = 0.5*(\sum_{x=15-19}^{45-49}[F_x(t)*P_{f,x}(t)] + \sum_{x=15-19}^{45-49}[F_x(t+1) * P_{f,x}(t+1)])$$

After constraining to projected State-level births, these were then used to calculate age 0 in the projected year:

(xii) $$P_0(t+1) = B(t) * (1-Q_b(t))$$

SLA migration departures were calculated by applying 2001 Census-derived departure rates to the population:

(xiii) $$DEP_x(t+1) = P_x(t+1) * DEPRATE_x$$

Total SLA arrivals were then derived using the pre-set net migration assumptions:

(xiv) $$ARR(t+1) = NM(t+1) - \sum_{x=0}^{x=max} DEP_x(t+1)$$

(xv) The assumed age-specific arrival levels were derived from 2001 Census data. Together with departures from (xiii) these were simultaneously constrained (via IPF - see xvii - xix) to:
(a) SLA arrival and departure totals
(b) State age-specific net migration

Then the arrivals and departures were applied to the population projected so far:

$$(xvi) \quad P_X(t+1) = P_X(t+1) + ARR_X(t+1) - DEP_X(t+1)$$

Year t+1 then became the base for projecting the next year and the cycle was repeated until the final projection year was reached. However, before $P_X(t+1)$ became the new base, the projected SLAs were constrained to sum to the State-level projection. This involved a final iterative proportional fitting process, the year is t+1:

SLA	->	Statistical Local Area
ACT	->	The Australian Capital Territory
a	->	first SLA
z	->	last SLA
r	->	SLA number

Scale the SLA totals to the State total.

$$(xvii) \quad P^{SLA} = P^{SLA} * \left(P^{ACT} / \sum_{r=a}^{r=z} P_r^{SLA}\right)$$

For each SLA, scale all ages to sum to the new SLA total.

$$(xviii) \quad P_X^{SLA} = P_X^{SLA} * \left(P^{SLA} / \sum_{x=0}^{x=max} P_{Xr}^{SLA}\right)$$

For each age, scale all SLAs to sum to the State total.

$$(xix) \quad P_X^{SLA} = P_X^{SLA} * \left(P_X^{ACT} / \sum_{r=a}^{r=z} P_{Xr}^{SLA}\right)$$

Stages (xviii) and (xix) were then iterated several times before the resulting matrix was rounded.

Step 3

This involved splitting the completed SLA projections into Census Collection Districts.

(xx) Each CD's ERP aged 18 and over was extrapolated linearly to June 2009 of each, based on June 2001 - June 2003 data.

(xxi) Results from (xx) were aligned so they summed to the SLA projections. Two approaches were used for this:

(a) If extrapolated CDs sum to less than projected SLAs (or both projection & extrapolation falling) then scale all CDs in the SLA prorata.
(b) If the extrapolation was growing faster than the projection, scale down only the growth CDs according to their share of the growing CDs.

This dual approach improved the results for CDs in SLAs where there was widely divergent CD growth.

Note: CD ERP uses building approval data by dwelling-type to incorporate differential growth of CDs when disaggregating post-censal SLA ERP. This affects total CD growth rather than targetting age/sex population change. By constraining to SLA ERP it indirectly 'ages' individual cohorts but resulting CD ERP will tend to reflect the 2001 Census age/sex profiles more than would actually be the case in subsequent years.

Recently available 2003/4 building approvals by CD were also examined. In essence CDs with many approvals but whose extrapolation/projection was not showing growth had extra growth phased in over 3 financial years (to allow for occupancy lags).