POLICY EVIDENCE SUMMARY May 2024

Improving small area population projections

AHURI

Based on AHURI Final Report No. 420: Improving small area population projections

What this research is about

This research critically assesses the population projection methods and resources available for use by Australian decision-makers and planners. It examines how these projections inform policy decision-making; the types of decision-making supported by current projection datasets; the relative trade-offs made around reliability and certainty; and what opportunities exist for methodological and data improvement and future innovation.

The context of this research

Quality population projections provide governments and providers of housing, infrastructure and services with the ability to plan for the short and long term, while making explicit the underlying assumptions, data, and potential for error. Demographic factors are vital components to understanding future population, economic, environmental and social change.

The key findings

Population projections can range from covering the national scale to small areas; for Australia, the geographical hierarchy progresses from the national to the state level, and then to a range of statistically and administratively defined sub-regional geographies. Most policy and decision-making is performed at these administratively defined levels, with projections calculated for Greater Capital City Statistical Areas (GCCSA); Local Government Areas (LGAs); postcodes and suburbs; and ABS Statistical Area Levels 4 to 1 (SA4 to SA1).

The basics of population projections: Top-down population model and Bottom-up population model

In a top-down model, larger spatial units are used to control the smaller area projections. For example, the Australia projection is used as a control total for the state and territory projections and, in turn, these are used to control the SA4 projections. In these cases, the total population for Australia is used to constrain the sum of the state and territory projections (and so on through the smaller spatial units). In this modelling, the sum of the smaller parts can never exceed the total of the controlling spatial unit.

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In the bottom-up model, the smaller area projections are added together to form the larger spatial units.

There are arguments to support both types of models: the demographic inputs for larger spatial units (Australia and States for example) are more reliable, while as the population (and spatial units) gets smaller, demographic data may be less reliable due to small numbers or missing data. Small area projections will have better input of local policy, land availability and development data, which in turn provides a realistic base for population growth. However, it may overestimate growth trends when the land development driving historic growth is no longer available. Both are valid models, and a hybrid model that incorporates top-down and bottom-up projections may well provide a better outcome.

The top-down approach prioritises accuracy at a larger spatial scale and generally over longer horizons. In comparison, the bottom-up approach places greater importance on regional specificity and short- to mid-term horizons.

The main population projection methods currently in use

The **cohort component method** is arguably the most widely used projection method both nationally and internationally, and is the preferred method for national, state and regional level projections. The method has two major components: (a) the whole population of an area at a given time is divided into cohorts (such as by age or gender), and (b) demographic components of change, fertility, mortality and migration are modelled over these cohorts. The method is used by the ABS at the national level, and by the State Planning Departments at state and sub-state spatial units (SA3, SA2, Local Government Area levels).

The strength of this approach is the detailed use of demographic data and detailed age and sex. It has a weakness because it does not include details on land and dwellings. At the regional level, demography drives the housing market, but at the local level it is the housing stock that shapes the demography (i.e. any population increase cannot exceed the number of available dwellings). Consequently, what is a strength at the small scale is a weakness at the large scale as land availability and dwelling type are significant constraints on what can occur. This is why most of the states have developed mixed models that use both the cohort component model and varying degrees of land availability.

Trend exploration methods are simple mathematical functions that extend a trend observed over a specified base period into the future. While these methods are easy to use and require minimal inputs (since only past populations and some upper/lower constraints are needed), their reliability varies; an area experiencing very little population change over time might perform quite well, whereas an area experiencing significant growth or decline may perform very poorly. Trend exploration methods are typically unreliable unless used in conjunction with cohort component models.

Comparative methods, or ratio-share models, use larger area population projections to create smaller, sub-regional area projections using relationships such as the share of population, the share of growth, or the growth difference. (Share of population methods simply assign a portion of the larger region's population to the smaller component areas.) Outputs of comparative or ratio-share models are generally more useful in the short term.

Economic base methods derive population projections by applying a population/employment ratio of a local area. They assume that economic change is a primary driver of demographic and social change, and are most frequently employed in circumstances where the introduction of a large-scale project is likely to result in shifts in the population.

These methods are particularly relevant for resource driven areas (such as mining in Western Australia), where the economic sector dominates all other sectors. However, these methods are inappropriate for more diverse areas where factors such as housing; family requirements of education or leisure; climate and other amenity driven growth; or changing commuting patterns (such as the relationships of satellite towns to metropolitan areas) are important.

Housing unit methods base population change on the approvals, completions, demolitions and projections of the number of new and existing stock of housing units in an area. These calculations include estimations, or future scenarios, of occupancy rates (proportions of units occupied on a usual residence basis), vacancy rates (proportions of units not occupied on a usual residence basis) and other factors such as average household size.

Although there are no direct models of population change processes built into these methods, when used in conjunction with cohort component models, housing unit methods are particularly appropriate for local area projections. Accessing some key data can be difficult and inconsistent across local government areas, states and territories.

Land use allocation methods employ independent projections of dwelling units for a larger area, distributing these over smaller local areas, based on each small area's probability of development. This probability is affected by factors such as the amount of available land; land zoning regulations; distance from employment nodes; transportation connectivity and availability; access to schools and retail facilities; and adjacency to existing development. Land use allocation models mimic the land development process so are not a population projection method per se, but when combined with housing unit and cohort component models they provide conceptually more appropriate projections. The methods are highly dependent on the quality and scale of the available data.

Averaged and integrated projections from the various projection methods described previously can be averaged into single, integrated projections. The assumption is that producing a smoothed average from multiple methods results in a lower error in practice, and therefore reduces the variance introduced from the different projection methods.

However, in an integrated approach, the projections from the individual input models need to be of high accuracy and reliability. If the errors in individual forecasts were too low or too high, a smoothed average would include this range of errors. Averaged and integrated projections can also be time consuming, as they require multiple models to be run separately to produce a single average.

Small area forecasting models are top-down cohort models informed by bottom-up land/housing constraint models. It is the combination of three models (cohort component, household propensity and housing unit) that allow both the demography and local conditions to drive small area forecast results, while inputs on residential development constrain the population to accord with availability of land and housing.

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Other developments gaining attention are the use of novel data sources (such as satellite imagery) and novel methods, such as machine learning, to model population projections, mobility and migration. However, these are still in the development stages.

Evaluating models that are used currently

Between 2017 and 2021, the ABS projection estimated a population increase of 1.7 million people. The 2021 Census population count (ERP) suggests that the actual increase was smaller, with an over-projection of just over 600,000 persons for the period, largely driven by New South Wales and Victoria. This could be seen as a function of the COVID-19 pandemic which severely limited overseas migration for two of these years, and interstate and intrastate migration was limited. This was an unexpected but dramatic influence on the traditionally predictable flows of population into and out of Australia.

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Interestingly, in some states and territories, COVID-19 restrictions resulted in an under-projection, while in others an over projection was evident. This is no doubt related to a combination of the relative scale of migrant arrivals to states, the porosity of state borders during COVID-19 restrictions and traditional intrastate population flows. The short-run results prepared by the state agencies performed well, particularly in the wake of the COVID-19 pandemic and changes to migration.

What is evident from this evaluation is that the population estimate errors are more likely to be larger in the population that is more mobile (late teenagers and 20s) and the 0—4 cohort. The latter may indicate an issue with the fertility assumptions, while the former is more likely an issue of the way mobility is measured in Australia. Younger people are quite mobile but do not always update their address details or may maintain their address at their parents' house and this will only be identified every five years when the Census is collected. This is more problematic when developing assumptions for intrastate and interstate migration for smaller population spatial units.

There were also some very large errors in the capital city LGA projections. However, this is most likely an impact of the COVID-19 pandemic, lockdowns and national and state border closures that stopped the flow of people, particularly students.

The use of population projections varies for different (and disparate) users

There are two main ways populations projects are used. The first, as used by national and state and territory government projection developer stakeholders, sees population projections as an official benchmarking tool for the allocation of funding and resources. In general, this means that projections are at the larger spatial level, have longer timeframes, and are predominantly based on demographic change. Within these contexts, forecasts represent a shared source of truth that is mandated and approved by government.

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The second way, as used by stakeholders from private enterprise, research and consultancy, sees population projections as important reflections of what is likely to happen on-the-ground, and are therefore characterised by shorter projection horizons; larger variety and quantity of input data; smaller spatial areas; and frequent updating.

Need for university trained demographers

Australia's ability to provide high quality and reliable projections is affected (and likely caused in part) by a national 'demography brain drain'. Anecdotal evidence suggests that the offering of demographic training has declined in Australian universities, and that there are relatively few graduates with high level skills. This is an area that requires action to ensure there is a qualified workforce in this field.

What this research means for policy makers

It is unlikely that the top-down and bottom-up methods could be unified to one nationally consistent approach that would fulfil different users' needs with sufficient accuracy. Instead, there is a place for both strong top-down projections and more flexible targeted bottom-up ones.

In order for future policy to be based on solid and reliable population estimates, this project suggests prioritising:

- consistent approaches and shared information sources
- good quality, reliable and timely data
- a thorough understanding of land and dwelling supply
- better methods (especially for estimating small area populations)
- a more widespread understanding of error and accuracy
- a solid pipeline of training in demographic skills.

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Methodology

This research combines quantitative spatial and statistical analysis, with qualitative semi-structured interviews with key stakeholders and a research evidence review.

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