CS&SS/SOC/STAT 563 — Statistical Demography — Spring 2022 - Homework 6

Due Monday May 23 at 2:15pm on the course Canvas website.

1. Using the converged TFR and e_0 simulations provided on the Homework web page, generate probabilistic population projections for all countries for 2020–2100. For Australia , generate and plot probabilistic projections of the following quantities to 2100:
   (a) total population
   (b) total male population
   (c) total population over 65
   (d) the potential support ratio, defined as the number of people aged 20–64 divided by the number of people 65 and over. (This is sometimes roughly referred to as the number of workers per retiree.) Comment on the trend in this quantity.

2. The probabilistic population projections in the previous question do not take account of uncerainty about future migration. This question involves taking a first approach to this.
   (a) Download the time series of net migration rates by five-year period for Australia from the UN's WPP website at
   https://population.un.org/wpp/Download/Standard/Migration/
   and write them out here in your homework.
   (b) Fit the first-order autoregressive (AR(1)) model given in the lecture to this series by finding estimates of the parameters in a frequentist manner (not using a Bayesian hierarchical model). What are your estimates of the parameters and their standard errors?
   (c) Find the analytic form of the predictive distribution of the net migration rate for Australia in 2020–2025 from this model.
   (d) Use the fitted AR(1) model to generate a sample from the predictive probability distribution of the net migration rate for Australia in 2020-2025, and show a histogram of the resulting values, with the analytic probability density function superimposed.
   (e) Specify an appropriate schedule of age-specific migration rates to break down your sampled all-ages net migration rates by age.
   (f) Using this and the population of Australia in 2020, generate a sample of vectors of projected age-specific net migration numbers for 2020-2025 and show histograms of the number for each age group.
   (g) By combining this probabilistic forecast of net migration in 2020–2025 with the probabilistic projections of fertility and mortality that you used in Question 1, generate a probabilistic projection of the Australian population by age and sex (and total) in 2025. Give medians and 95% intervals for the number of people in each combination of sex and age group.