

CS&SS/STAT 563 — Statistical Demography — Spring 2020 - Homework no. 2

Due Monday April 13 at 2:00pm on the course Canvas site.

1. Consider a one-sex closed population with 3 age groups. Their initial population, age-specific fertility rates (in expected births per individual in the next period) and survival probabilities are as follows:

Age	Population	Fertility rate	Survival prob
1	18,000	0	0.65
2	17,000	0.9	0.75
3+	14,000	0.2	0.15

Assuming that fertility and mortality rates for the population stay constant over time:

- (a) Find the crude birth rate for this population in the next period.
 - (b) Find the total fertility rate for this population.
 - (c) Write down the Leslie matrix for this population.
 - (d) Project the population by age forward one period.
 - (e) Project the population by age forward 10 periods.
 - (f) Find the crude birth rate and TFR for this population 10 periods into the future.
 - (g) Find the asymptotic rate of increase of the population
 - (h) Find the stable age distribution of the population.
 - (i) Find the reproductive value of individuals in each age group.
2. This question deals with estimating life tables.
 - (a) From the UN's 2019 *World Population Prospects*, extract the estimates of the age-specific mortality rates ${}_n m_x$ for females in Thailand in 2015-2020. Plot them against age on the raw and logarithmic scales, and comment on any unusual features.
 - (b) Using these, derive a life table for this population and time period. Show your working.
 - (c) Find the life expectancy at birth and at age 10 for this population.

3. This question deals with population projections for Thailand.

- (a) For each age group, calculate ${}_5\tilde{F}_x$, the expected number of live female births per woman per five-year period.
- (b) Using these numbers and the mortality rates from Homework 1, form and write out the Leslie matrix for this population. You can write out the full matrix or just report the non-zero elements, for example in the form (row number, column number, entry).
- (c) Assuming that fertility and mortality rates stay constant over time, and that net migration is zero at all ages, project the population forward one period from 2015, to 2020.
- (d) Under the same assumptions, project the population forward 15 years, to 2030.
- (e) Extract and write down the age-specific net migration rates in migrants per five-year period for 2015-2020 from the UN's 2019 *World Population Prospects*. Note that the UN gives net migration rates in terms of migrants per 1,000 person-years, so you will need to adjust their rates.
- (f) Assuming that age-specific net migration rates will stay constant to 2030, project the Thai population forward from 2015 to 2020 and to 2030.
- (g) Compare your population projections for 2020 and 2030 with migration to those without migration.