Midterm exam "Population Analysis"

i. On Wattle, students have access to the exam and data used at 9am.

ii. Each question (1, 2.a, 2.b, etc) is equivalent to 10% of the exam. Please answer all of them. An empty answer is a grade of zero on that question.

iii. Calculations will be needed to solve the exam and students can use any software for that (R, excel, any…). Please do NOT include excel files or R code in your answers, just the final output that you are requested, either a Number, a Table or Figure.

iv. Students should submit a PDF of their exam answers in turnitin before noon (12pm). Late submission (5% rate).

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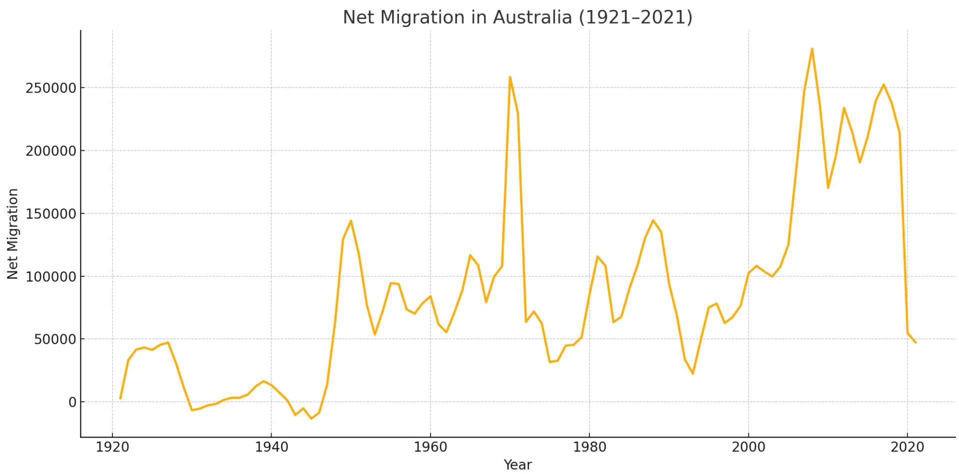
1. How would you describe *Demography?* Do you consider it is needed? Why? use your own words (no copy/paste from anywhere… it is really bad to have the same answer as somebody else… max 200 words)

At the theoretical level demography is the study of populations, this includes how they grow, shrink, age and move. The measure on which demography is based is births (without births there would be no populations and therefore the study of populations would not exist). it certainly studies inevitable events such as deaths and aging, but not only that also more arbitrary measures such as migrations helping us to understand not only how many people there are, but also how they live and change over time. demography is necessary because it shows with data (barplots, histograms, scatterplot and other statistical measures) how a population reacts to macro phenomena; what I mean is that we have seen how for example in the Hippy period there was a boom in births, or how when during the first world war life expectancy collapsed because of the war. Demography is needed for planning (even using synthetic data that is not very accurate, for example we have seen that we need to use period and not cohort data to talk to governments because they need simple information). I can interpretpopulation analysis as a "rudder" for policies because by looking at the past we can often hypothesize a trend, this is to say that it also helps to anticipate problems: for example, how to reverse the TFR trend below replacement level (tfr>=2), or how to sustain an aging population and then create a plan with economists and policymakers.

I mean we want tfr >= 2

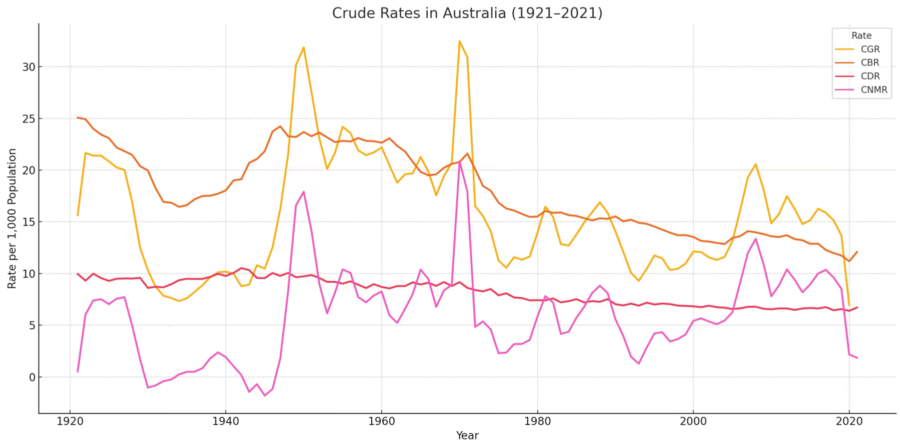
2.a) Calculate the net migration counts from 1921 to 2021, and present a plot with their time trend. Mention how you calculated the net migration counts, and discuss the maximum and minimum migration counts observed in Australia, and the years when they occurred. Why do you consider the max and min values were observed in those years (max 200 words)



Maximum net migration: 280,961 in 2008 : This likely reflects a period of economic growth and strong immigration policies that attracted more people to Australia.

Minimum net migration: –13,376 in 1945. This was just after WWII. The negative balance could be due to war-related population loss and restrictions on immigration during and right after the conflict.

2.b) Calculate the Crude Growth Rate (CGR), Crude Birth Rate (CBR), Crude Death Rate (CDR) and Crude Net Migration Rate (CNMR) for the years 1921 to 2021. Present one plot including the time trends in all those rates



2.c) Mention how you calculated the rates in 2.b and discuss, from your findings in the plot in (2.b), your vision of the future for the components of the population growth rate in Australia (i.e. the future for CBR, CDR and CNMR) (max 200 words).

1. Crude Birth Rate (CBR): Number of births per 1,000 population
2. Crude Death Rate (CDR): Number of deaths per 1,000 population
3. Crude Net Migration Rate (CNMR): Net migration per 1,000 population
4. Crude Growth Rate (CGR): Total population growth per 1,000 population

The calculation method involved: Using mid-year population (average of start and end year) as the denominator. For each rate: (Events/Mid-year population) × 1,000. For CNMR, I first calculated Net Migration. CGR equals the sum of CBR - CDR + CNMR

Crude Birth Rate (CBR): I think the CBR will likely continue its decline. This reflects the ongoing demographic transition, based on delayed childbearing, and changing family preferences (the priority is career and financial freedom). Australia's fertility rate is already below replacement level, and factors such as housing costs, and childcare availability suggest this trend will continue.

Crude Death Rate (CDR): probably the CDR will likely experience an increase in the coming decades due to population aging as the large Baby Boomer cohort reaches advanced ages. It is important to mention that this will occur despite continued improvements in healthcare and life expectancy (the deaths in younger ages will decrease.

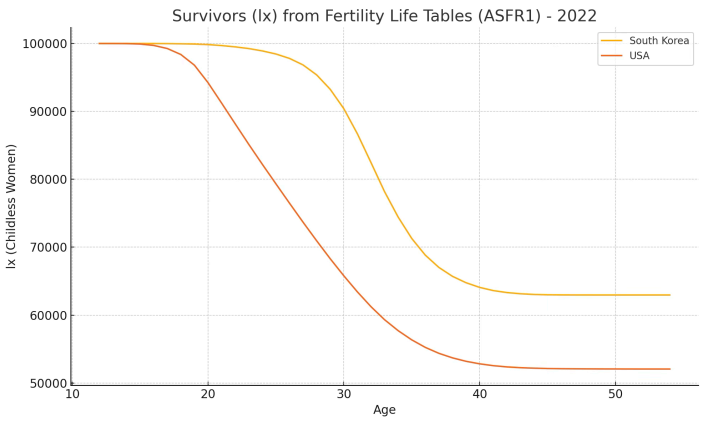
Crude Net Migration Rate (CNMR): Migration will remain the most volatile and policy-sensitive component. After recovering from the COVID-19 drop, I expect the CNMR to return to relatively high levels given Australia's attractiveness as a destination and its economic needs. This also caused by the "social movements" on tiktok, full of young generations who leave the home country (Europe, India ecc.) and decide to work in Australia. However, it will fluctuate based on economic conditions, policy changes, and global migration patterns.

Overall, Australia's population growth will increasingly depend on net migration as natural increase (births minus deaths) diminishes. The Crude Growth Rate will likely remain between 10-15 per 1,000 in the medium term, with migration contributing approximately two-thirds of that growth. This shift will have significant implications for Australia's age structure, labor market, and social services infrastructure.

2.d) Describe the theoretical age-pattern of migration and some of the reasons why it has that shape. Also discuss if you consider if humanitarian migration shows the same age-pattern? (maximum 200 words).

The theoretical age-pattern of migration usually shows a high peak in young adulthood, usually between ages 18 and 35. This is due to the life-course transitions like starting university, entering the labor market, or forming a new family. Migration at these ages is often driven by opportunity like educational, economic, or personal. There may also be a smaller peak in childhood, which often reflects family migration where children move with their parents. At older ages, migration tends to decrease significantly, except in some cases of retirement migration or health-related moves (but this occur in well-developed countries). Overall, this pattern reflects the fact that younger individuals are generally more flexible, mobile, and willing to take risks.
Humanitarian migration, however, may not follow the same age-pattern. It is often driven by external shocks. We can think about war, persecution, or natural disasters (which are increasing due to climate change), these events force entire families or communities to flee. As a result, humanitarian migrants may include more children, older adults, and a broader age distribution than voluntary economic migrants. In short, while economic migration is more focused on specifi age-range, humanitarian migration is often more inclusive across the age spectrum. (We can also think that in zone of war conflict like Ucraina and Russia or Palestine and Israel the young generation who are generally more propense to migrate decide to stay (or are forced to stay) for military reasons.

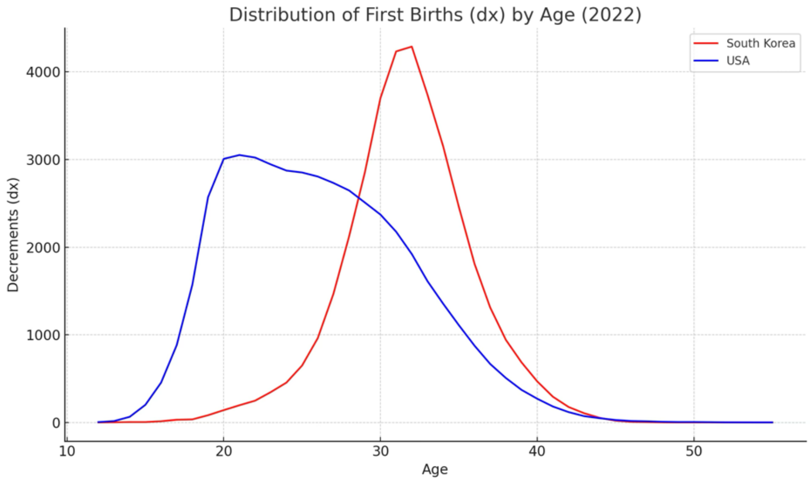
3.a) Present a plot including both the South Korea and USA “survivors”, lx, from your calculated ASFR1 life tables, and describe the trends. (max 200 words).



The graph shows the lx function derived from fertility life tables based on ASFR1 data for 2022, representing the number of childless women remaining at each age. In this context, “survival” refers to women who have not yet had a first birth. So we can see that in the USA, the lx curve starts to decline noticeably from age 20, reflecting that many women begin childbearing in their twenties. In contrast, South Korea’s lx curve declines much more gradually, with a significant proportion of women remaining childless even into their 30s. This difference reflects distinct fertility behaviors in fact in the US, early and mid-age fertility is still relatively common (even if with a decreasing trend), while in Korea, first births are increasingly delayed or eventually forgone. By age 30 and beyond, the divergence between the two countries becomes bigger, with Korean women having much higher levels of childlessness.

Finally the lx curve for Korea flattens earlier, indicating fewer transitions into motherhood across all reproductive ages. This aligns with Korea’s extremely low fertility rates in recent years and highlights that elements such as work pressure and housing costs truly influence delayed or foregone fertility.

3.b) Present a plot including both the South Korea and USA "decrements", dx, from your calculated ASFR1 life tables, and describe the trends. (max 200 words).



The plot shows the distribution of first births (dx in this special case) by age for South Korea and the USA in 2022, derived from fertility life tables assuming a cohort of 100,000 childless women at age 12. The curve for the USA is notably higher across all reproductive ages, reflecting higher fertility rates for first births. In the USA, the peak in first births occurs in the late 20s to early 30s, with a relatively smooth and symmetric decline after age 30. Conversely, South Korea's curve peaks sharply around age 30 and is much lower overall, indicating lower fertility and a more delayed timing of childbearing. The Korean curve is more compressed and concentrated in a very limited age range, reflecting patterns of postponement and fewer first births overall. These trends suggest a more accelerated fertility in the USA and stronger fertility postponement in Korea.

3.c) For each, South Korea and USA populations, present a Table including TFR and the Mean Age at Childbearing (MAC) for each of ASFR & ASFR1, and two new measures based on the ASFR1 life table: the Proportion of Females Remaining Childless (PFRC) and the "Life Expectancy between ages 12 and 55" (LE(12to55)). Mention how you calculated the PFRC? (max 100 words).

MEASURE	SOUTH KOREA	USA
TFR (ASFR)	0.779	1.657
MAC (ASFR)	33.4	29.9 years
TFR (ASFR1)	0.455	0.643
MAC (ASFR1)	32.8 years	27.8 years
PFRC	63%	52.1%
LE(12to55)	35.2 years	30 years

Note: for some of these calculations I had to use slightly approximate numbers

The Proportion of Females Remaining Childless (PFRC) was calculated as the final lx value in the ASFR1 life table divided by the initial population of 100,000. This represents the proportion of the initial cohort who never experience a first birth by age 55. For South Korea, this is 63.0%, indicating that nearly two-thirds of women would remain childless under current first birth rates. For the USA, the PFRC is 52.1%, which is almost 10% less then south korea. South Korea shows significantly lower fertility than the USA across all measures.

3.d) How big or small are the disparities between South Korean and the USA in: TFR, MAC, PFRC and LE(12to55) in (3.c) above? What is each measure telling us? (max 200 words).

TFR (Total Fertility Rate): South Korea's TFR (0.779) is less than half of the USA's (1.657), representing an extremely low fertility rates. This 0.878 gap indicates that Korean women have far fewer children on average, well below replacement level, suggesting rapid future population decline without immigration.
MAC (Mean Age at Childbearing): Korean women have children 3.5 years later on average (33.4 vs 29.9), reflecting delayed family formation, likely due to extended education, career prioritization, marriage postponement, and different social norms around parenthood.

TFR1 (First Birth TFR): The gap of 0.188 (0.455 vs 0.643) shows that fewer Korean women become mothers at all, not just that they have fewer children per mother. MAC1 (First Birth MAC): The 5-year difference (32.8 vs 27.8) confirms Korean women delay entry into motherhood substantially longer than American women. PFRC (Proportion Remaining Childless): At 63.0% vs 52.1%, the 10.9 percentage point gap reveals that significantly more Korean women would remain childless under current rates. LE(12to55): The 5.2-year difference (35.2 vs 30.0) shows Korean women spend more of their reproductive years childless, that make sense with later and less common transitions to motherhood.

3.e) What did we gain from applying the life table to the age-specific fertility rates for first births (ASFR1), specially what are PFRC and LE(12to55) adding that we didn't have already from the TFR and the MAC? Explain your answer (max 200 words).

The PFRC quantifies lifetime childlessness under current conditions, that was impossible to deduct directly from TFR or MAC. While TFR1 gives the average number of first births per woman, it doesn't clearly communicate eventual childlessness. PFRC makes this explicit, showing that 63% of Korean women would remain childless under current rates.
The LE(12to55) measure captures the average time spent childless during reproductive years (after 55 asfr are always 0). This years range reveals that Korean women spend 35.2 years childless versus 30.0 for American women. This measure uniquely quantifies the duration of childlessness, not just its eventual prevalence (PFRC) or the average age of transition (MAC1).

The life table measures transform period rates, creating a "synthetic" experience. They provide intuitive, population-level info about the childlessness experience: both its prevalence and duration that traditional period measures can't directly supply.

Additionally, the life table framework offers a consistent methodology for studying other family transitions like marriage or second births, allowing for comparable analysis across different demographic processes and populations.