Country: Japan
Year: 2010

(An Application of the Leslie Population Model). An important usage of a population Census is to predict future long term growth rate of the population of a country and the age distribution of its population. In this project, you and your team will use (country/state of your choice) census data and the Life Table to predict the future population of and its age distribution with the Leslie Population Model. Inform your instructor the names of your team members and the country/people group you are investigating.

(a) Download fertility rates of women in your people group from internet search. You should have **hardcopies** of your reference and state in your work which document you have obtained your rates from. State also the year the data was obtained.
Fertility rates of women in Japan in the year 2010 were collected from the Human Fertility Collection (HFC). Data for 2010 was collected in 2013. A hard copy of the fertility table is included at the end of this report. Fertility data is given for ages 16-50. This is because above 50 and below 16, fertility values are so low they would not make a significant contribution to the population estimation. Ages outside this range are also not typical child bearing ages.
(b) Obtain the Life Table for your selected people group. If you cannot find the Life Table for your people group, use the best information you could find to estimate the survival rates needed for the Leslie Population model. Explain your decision.
Our life table includes survival rates in intervals of one year, starting at age zero through 100 years old. We used data collected through the Human Fertility Collection (HFC), which sources from the Human Fertility Database (HFD). Our data in particular, was collected in 2013 and details female survival rates in Japan for 2010. The source that we found included separate survival rates for these ages for both males and females, so we did not adjust the data in any way.
(c) You must input the raw data in (a) and (b) on a data page in an Excel file. Each member of your team must have a copy of the file. DONE

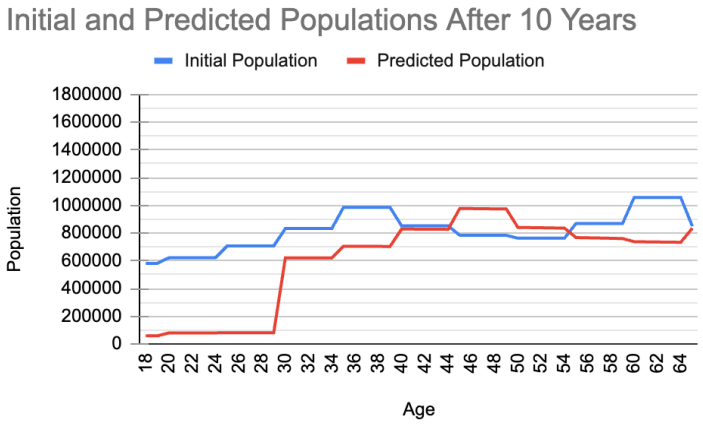
(d) What is youngest age group in your model? What is oldest age group in your model? How many survival rates do you have?
The youngest age group in our population is 0 years of age, while the oldest age group is 100 years old. We have 101 survival rates, one survival rate for each age. Since our fertility rates are adjusted to only include births in terms of female births, our survival rate is only for the female population.
(e) Explain any estimations or adjustments you made for the fertility rates of your people group.
Adjusted the fertility rate using the sex ratio of males:females in the 2010 Japanese population.

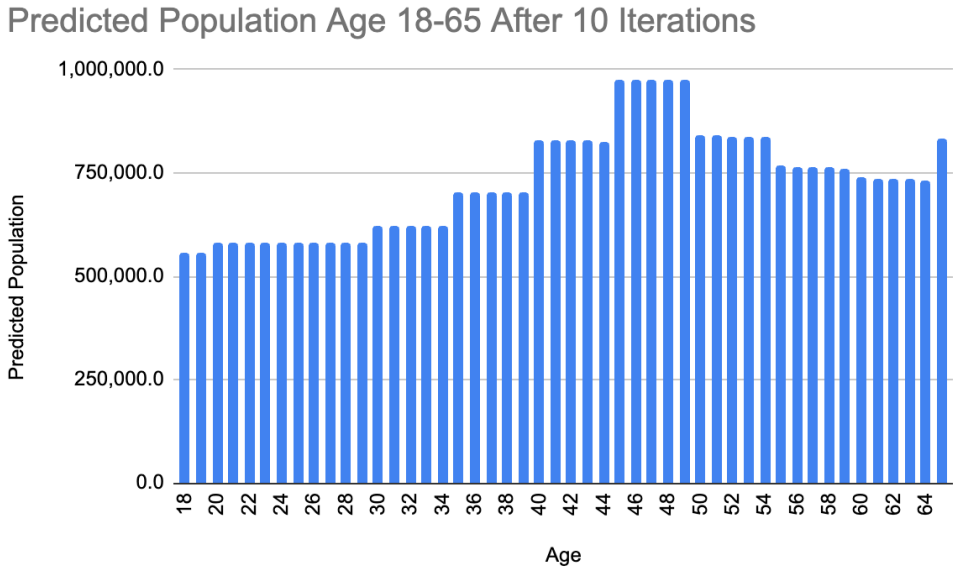
(f) What is the size of the Leslie matrix for your model? Construct the Leslie matrix on a SEPARATE page in your Excel file containing your census data.

- 101 x 101

(g) Use your model to find the predicted size of the age group 18 - 65 years old for the next ten years. You may study as many group or sections of your population to illuminate any interesting facts from

your data. State the initial population you are using. Chart your answers in a table and use Excel to draw a graph for your future projections. Comment on your results and any implications they may have.





(h) Use MATLAB to analyze your matrix. Explain the significance of the information you extracted from the Leslie matrix. What are the names of the information you found?

Dominant Eigenvalue, steady state, and growth rate included in attached spreadsheet under “Predicted Model 18-65 years”

(i) Write a short report (one to two pages) on your projections. Give both numbers and their meaning. You should discuss the implications of your projections. These implications could be, but not limited to, recommendations you have for the current government or any special interest groups of your choosing. You are encouraged to be imaginative and yet exacting in your report.

MATH 20480
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Final Project

From the computed steady-state population, it was determined that higher percentages of the population were associated with older ages. This can be seen in the age range 0-81. In this range, the highest steady state value is achieved at age 81, with a value of 0.01348604798. From 0, the steady state population values increase until 81. Additionally, the steady state population values reach a value of at least 0.01 at age 38, and increase until the value of 0.01348. Since the steady state values increase and reach a maximum at age 81 and have the highest values among some of the older ages (38-81), Japan has a declining population. This is because Japan has fewer younger people that are in the fertile window, which is explained by the steady-state population vector.

Japan's declining population compared to the initial population in 2010 is demonstrated by the predicted growth rate model. In the predicted growth rate, compared to the initial population, we see a decrease in newborns. This is cause for concern as the initial population already had fewer young people compared to older ages. This leads to the predicted model having lower values than the initial population until age 45. This continued shift towards an older population raises concern.

The declining population of Japan is exaggerated by the fact that the 21-34 age group has the highest fertility rates of the population. The ages of 21-34 have the highest fertility rates of the population and thus contribute the most to the growth of the Japanese population. From age 35, fertility rates start to decline. A decline in this population group of 21-24 means that fewer individuals with the highest fertility rates will be contributing to Japan's growth, which could have detrimental effects on the country's overall population growth..

Several implications can be drawn from the decreasing female population, especially among the age group 18-65. This age group's decline meant fewer working-age women were available to support Japan's elderly population, both economically and as caregivers. Additionally, among women in Japan, there has been a growth in healthcare jobs. This highlights that Japan has an aging society and thus has a demand for caregiving labor to support its aging population (Statistics Bureau of Japan, 2010).

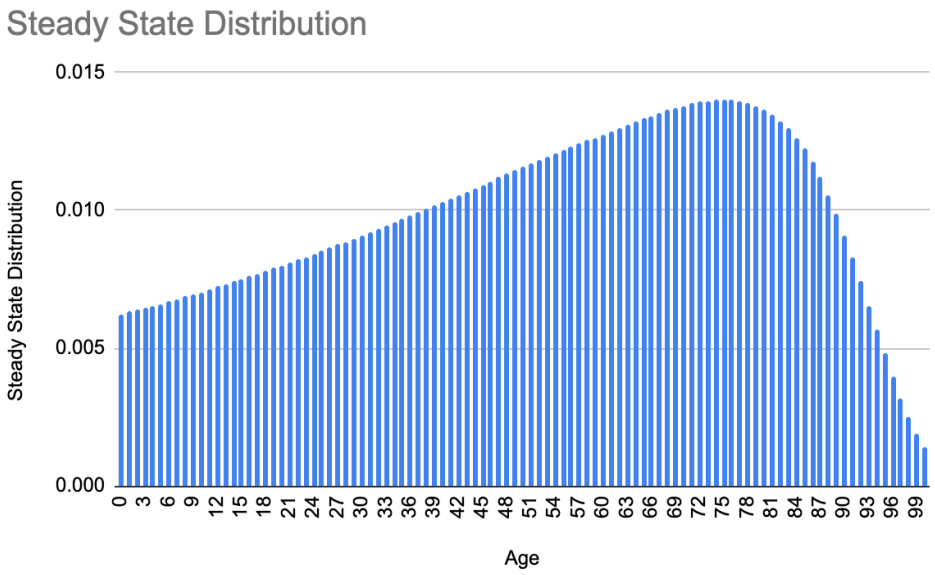
The declining population can also be attributed to a change in social norms and family dynamics in Japan. An increasing number of women aged 30–44 remained unmarried compared to previous generations. The never-married rate for women rose significantly, and thus traditional family structures weakened (Statistics Bureau of Japan, 2010). Women's priorities diversified

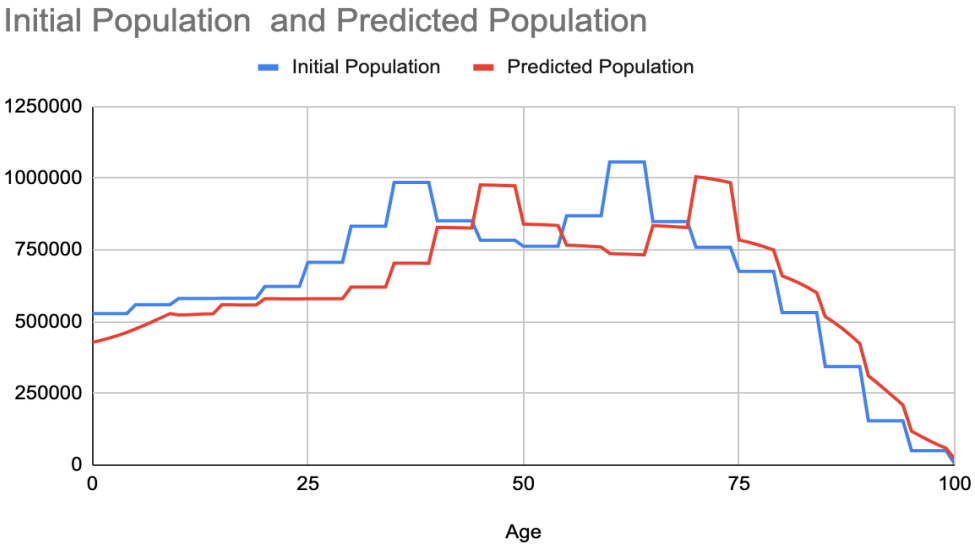
beyond marriage, influencing lower fertility and changing housing and consumption trends. This is illustrated by the fact that compared to 1985, women aged 25–34 in 2010 showed much higher labor participation, indicating an increased commitment to careers (Statistics Bureau of Japan, 2010). Policies promoting work-life balance, such as subsidized child care, were needed to encourage family formation.

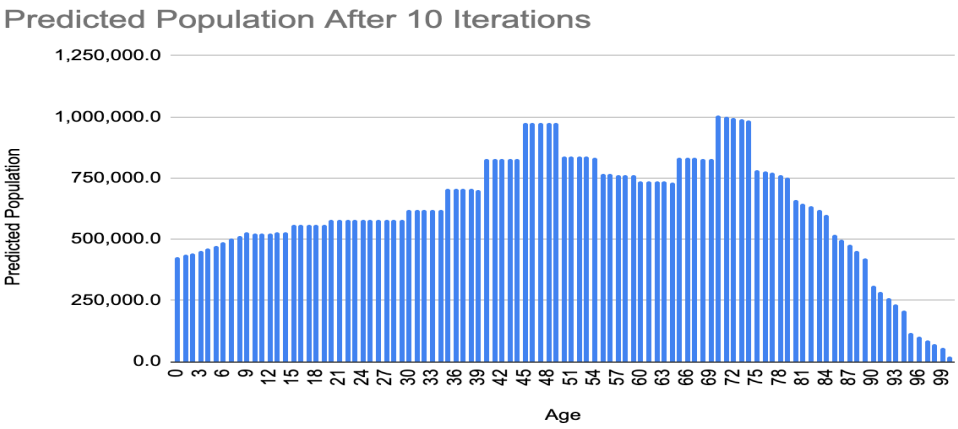
Based on our data analysis, we suggest that the Japanese government address the realities of delayed marriage and declining fertility among women. The Japanese government can implement this by providing housing subsidies for first-time married couples and single-parent households led by women. Additionally, the government can create flexible housing policies, which would promote co-housing and intergenerational housing models that reduce caregiver isolation. Expanding public coverage for infertility treatments and education on fertility health could help increase fertility as well. The government can also implement public messaging that promotes non-traditional career and family paths. All of these suggestions can address delayed marriage in Japan and help address the declining fertility rate.

We also considered addressing the immediate effect of caring for a society that is predominantly older with immigrants. We considered this since immigration will have more of an immediate effect on helping societal problems related to underemployment. This is because it can take decades for the benefits of increased fertility to takehold. Thus, the Japanese government could establish a caregiving visa category with minimum wage floors, health benefits, and grievance mechanisms. The government could fund language education and orientation programs to help migrants integrate socially and professionally. From there, the Japanese government could offer long-term visa options or permanent residency for caregivers who meet service duration thresholds. The Japanese government could leverage immigration to address labor shortages in any industries affected by an aging, dependent population. However, for years the Japanese government has been very particular and strict about immigration. Additionally, from a cultural perspective, Japan is not a multicultural society and prefers the traditions and presence of its people. Given Japan’s resistance to immigration and a strong preference for its traditions, encouraging immigration may not be a practical or widely accepted solution to underemployment.

Graphs:


Steady State Distribution
Steady State Distribution
0.015
0.010
0.005
0.000
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90 93 96 99
Age


Initial Population and Predicted Population
Initial Population
Predicted Population
1250000
1000000
750000
500000
250000
0
0
25
50
75
100
Age


Predicted Population After 10 Iterations
Predicted Population
1,250,000.0
1,000,000.0
750,000.0
500,000.0
250,000.0
0.0
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 75 78 81 84 87 90 93 96 99
Age

Sources

- https://www.fertilitydata.org/File/GetFile/Country/JPN/JPN_03_TOT.txt
- https://www.ipss.go.jp/site-ad/index_english/esuikei/econ3.html#:~:text=Regarding%20the%20sex%20ratio%20at%20birth%20(the,to%20remain%20constant%20for%202011%20and%20thereafter.
- https://www.mhlw.go.jp/english/database/db-hw/lifetb21th/index.html
- https://www.populationpyramid.net/japan/2010/