TEXAS A&M UNIVERSITY

SOCI 633–500/320–500
Demographic Methods
Spring 2025

ASSIGNMENT3
Cohort Mortality, Cohort Fertility, Population Projection
Due by April 14, 2023 (Monday) at 11:59pm
Percent of final grade: 20%

Instructor information

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Submission

This assignment should be submitted through Turnitin within Canvas. Turnitin is an online database system designed to help instructors **detect plagiarism**, track citations, facilitate peer reviews, and provide paperless grading markup in written assignments. Students should develop this assignment **individually**.

Answers to substantive questions should be around 150 words (for each question) and be written in Microsoft Word. The Word document should be on US Letter paper size, one-inch margins, Arial font, size 11, 1.5 line spacing. Answers to methods questions should be solved in Microsoft Excel, but the final results and interpretations should be exported and properly formatted in the Word document. Students should include detailed formulas utilized to answer the questions in Word and Excel. Students should submit both the Word file and the Excel file on Canvas.

Look at examples of how to properly format tables and figures in Word at http://www.ernestoamaral.com/docs/soci633-25spring/Examples_tab_fig.pdf.

See examples of how to place tables and figures in your document, as well as of how to cite them throughout the document on this link (http://www.ernestoamaral.com/papers.html).

Purpose

The purpose of this assignment is to test the knowledge about topics on cohort mortality, cohort fertility, and population projection, as discussed in the classroom and course material. These topics are the foundation to understand a series of demographic methods discussed throughout this course.

Main references

Poston, Dudley L.; Bouvier, Leon F. 2017. **Population and Society: An Introduction to Demography**. New York: Cambridge University Press. 2nd edition.

Wachter, Kenneth W. 2014. **Essential Demographic Methods**. Cambridge: Harvard University Press

Cohort mortality (7.5 points)

Questions 1.1, 1.2, and 1.3 are worth 1.5 points each. Question 1.4 is worth 3 points.

1.1. The cohort of French women born in 1890 were 28 years old when, at the end of World War I, the influenza pandemic of 1918 struck. With a radix l_0 = 100,000, cohort deaths were $_{27}d_0$ = 29,006, $_1d_{27}$ = 512, $_1d_{28}$ = 1,052, $_1d_{29}$ = 439, and $_1d_{30}$ = 405. Find $_1q_x$ for x = 27, 28, and 29. If the cohort's actual initial size was 409,907, how many excess deaths did the cohort suffer in 1918, compared to the average of 1917 and 1919?

1.2. Projected probabilities of survival for U.S. women and men for a cohort born in the early 1990s are shown in Table 3.7, taken from the same forecasts as Figure 3.4 with a radix of 1. Suppose you belonged to this cohort. What is your probability of surviving from age 17 to age 25? From age 17 to age 75? From age 17 to age 90? From age 17 to 100?

Table 3.7 Survivorship forecasts for a U.S. cohort

x	17	25	75	90	100
Male ℓ_x	0.98436	0.97571	0.70231	0.26753	0.03327
Female ℓ_x	0.98809	0.98488	0.78552	0.39044	0.07363

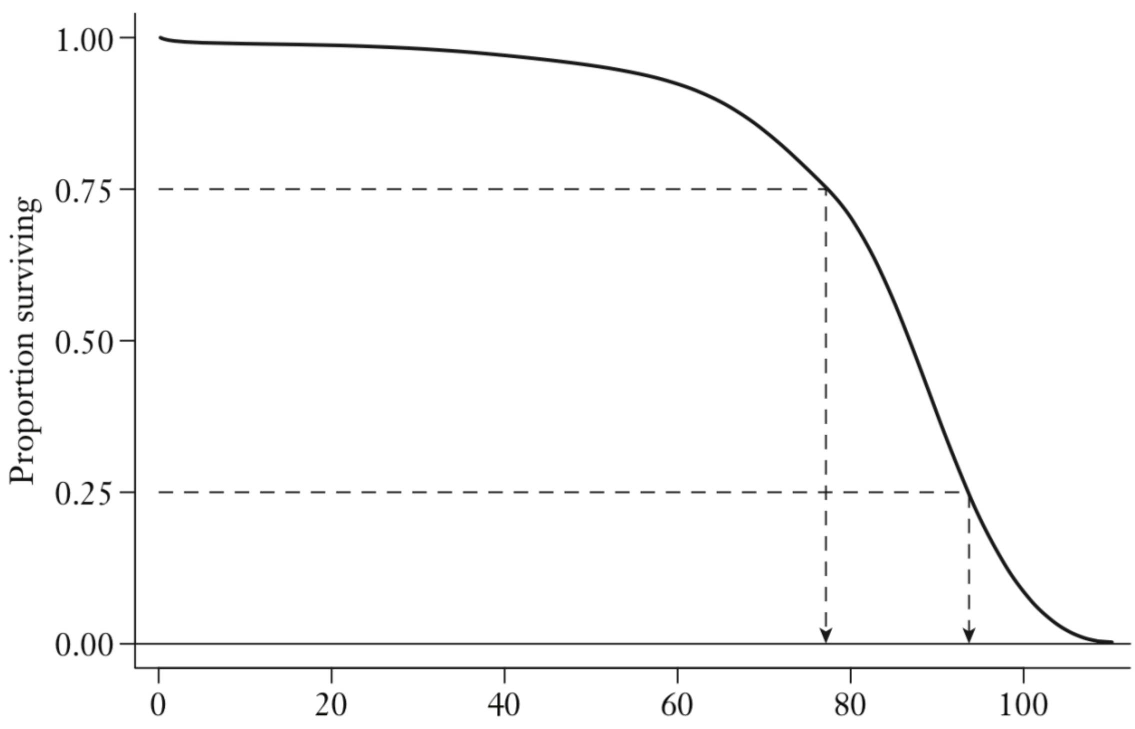


Figure 3.4 An ℓ_x curve

1.3. For the children of King Edward III, whose birth and death dates are given in Table 3.2, how much would the expectation of life at birth change if William of Hatfield were added with a death age of 1 month?

Table 3.2 Children of King Edward III of England

1330–1376	Edward, The Black Prince
1332–1382	Isabel
1335–1348	Joan
1336–?	William of Hatfield (died young)
1338–1368	Lionel of Antwerp, Duke of Clarence
1340–1398	John of Gaunt, Duke of Lancaster
1341–1402	Edmund Langley, Duke of York
1342–1342	Blanche
1344–1362	Mary
1346–1361	Margaret
1355–1397	Thomas of Woodstock, Duke of Gloucester

1.4. Select one country from each continent (Africa, America, Asia, Europe, Oceania) and collect data on crude death rate (CDR), life expectancy at birth (e0), life expectancy at age 15 (e15), infant mortality rate (IMR), and adult mortality between ages 15 and 60. Estimate lifespan at age 15. All these measures should be selected for both sexes combined and for 2020, 2050, and 2100. Organize all this data in table format and include in your report. You can organize all this data in a single table as illustrated on Table 1. Interpret these indicators by mentioning the specific contexts of each country and highlighting differences across countries.

Instructions to download data:

a. Search for data at the United Nations Population Division (https://population.un.org/wpp/). Remember that these are period data, not cohort data.

b. Click on icon "Download Data Files." Or click on menu "Data" and option "Download Center."

c. Select "Standard Projections" and the "Most used" topic.

d. Download "Compact (most used: estimates and medium projections) (XLSX)."

e. Search for 2020 data under the "Estimates" tab and for 2050 and 2100 under the "Medium variant" tab.

Table 1. Mortality indicators for selected countries, 2020, 2050, and 2100

Country	Year	CDR (‰)	e0	e15	Lifespan at age 15	IMR (‰)	Adult mortality, ages 15–60 (‰)
Country 1	2020						
	2050						
	2100						
Country 2	2020						
	2050						
	2100						
Country 3	2020						
	2050						
	2100						
Country 4	2020						
	2050						
	2100						
Country 5	2020						
	2050						
	2100						

Source: United Nations Population Division (https://population.un.org/wpp/).

Cohort fertility (7.5 points)

Questions 2.1, 2.2, and 2.3 are worth 1.5 points each. Question 2.4 is worth 3 points.

2.1. Table 4.2 provides data for a sample of 1,000 U.S. women randomly selected from the cohort born in 1934. Find the *TFR*, *GRR*, and *NRR* based on this data. Use information on fraction female at birth from Table 4.1 for 1934. Interpret the results. How close is the *GRR* to the *NRR*?

Table 4.1 Generation sizes and the *NRR*

Cohort	Babies	f_{fab}	Cohort Size	*NRR*
1910	2,665,122	0.4871	1,353,682	0.959
1922	3,579,318	0.4866	1,408,021	1.237
1934	3,231,638	0.4877	1,054,933	1.494
1947	3,788,342	0.4871	1,884,884	0.979

Table 4.2 A cohort *NRR* from U.S. age-specific rates

x	${}_5f_x$	${}_5L_x$	Babies
0	0	4770	0
5	0	4726	0
10	0	4712	0
15	0.0811	4698	381
20	0.2384	4681	1116
25	0.1969	4662	918
30	0.1033	4637	479
35	0.0313	4604	144
40	0.0046	4561	21
45	0.0009	4503	4
			3,063

2.2. Table 4.6 shows estimates of cohort age-specific fertility rates and person-years lived for the cohort of Swedish women born in 1800. The radix is 1,000. Find the cohort *NRR*, *TFR*, and *GRR*. How close is the *GRR* to the *NRR*? Value of fraction female at birth is unknown, so you should use 0.4886, according to Watcher (2014, p.81).

Table 4.6 Data for the 1800 cohort of Swedish women

x	${}_5f_x$	${}_5L_x$	x	${}_5f_x$	${}_5L_x$
15	0.0122	3,134	35	0.2131	2,663
20	0.1038	3,036	40	0.1136	2,509
25	0.2211	2,930	45	0.0182	2,351
30	0.2408	2,808			

Source: Keyfitz and Flieger (1968).

2.3. Table 4.7 shows women by parity at ages 45 to 50 in the whole sample from the 2004 Demographic and Health Survey (DHS) in Malawi. Calculate counts of women at and above each parity along with the values of *PPR*(*j*) for all *j*. Calculate estimates of the cohort *TFR* and *GRR* for this cohort from Malawi.

Table 4.7 Women by completed parity, Malawi, 2004

Parity j:	0	1	2	3	4	5	6	7
Women $w(j)$:	17	18	44	45	48	62	107	95
Parity j:	8	9	10	11	12	13	14	15
Women $w(j)$:	96	92	69	47	22	5	2	1

Source: Demographic and Health Survey (DHS), Malawi, 2004.

2.4. For the same countries from question 1.4, collect data on crude birth rate (CBR), total fertility rate (TFR), mean age of childbearing, net reproduction rate (NRR), and age-specific fertility rates (ASFR) from 15 to 49 years of age. All these measures should be selected for 2020, 2050, and 2100. Organize all other data in table format and include in your report. You can organize all this data in a single table as illustrated on Table 2. For *ASFR*, present the data in one figure per country (one line per year interval), utilizing the same scale on the vertical axis for all figures (see example on Figure 1). Interpret these indicators by mentioning the specific contexts of each country and highlighting differences across countries.

Instructions to download data (CBR, TFR, mean age of childbearing, and NRR):

a. Search for data at the United Nations Population Division (https://population.un.org/wpp/). Remember that these are period data, not cohort data.

b. Click on icon “Download Data Files.” Or click on menu “Data” and option “Download Center.”

c. Select “Standard Projections” and the “Most used” topic.

d. Download “Compact (most used: estimates and medium projections) (XLSX).”

e. Search for 2020 data under the “Estimates” tab and for 2050 and 2100 under the “Medium variant” tab.

Table 2. Fertility indicators for selected countries, 2020, 2050, and 2100

Country	Year	CBR (‰)	TFR	Mean age of childbearing	NRR
Country 1	2020				
	2050				
	2100				
Country 2	2020				
	2050				
	2100				
Country 3	2020				
	2050				
	2100				
Country 4	2020				
	2050				
	2100				
Country 5	2020				
	2050				
	2100				

Source: United Nations Population Division (https://population.un.org/wpp/).

Instructions to download data (ASFR):

a. Search for data at the United Nations Population Division (https://population.un.org/wpp/). Remember that these are period data, not cohort data.

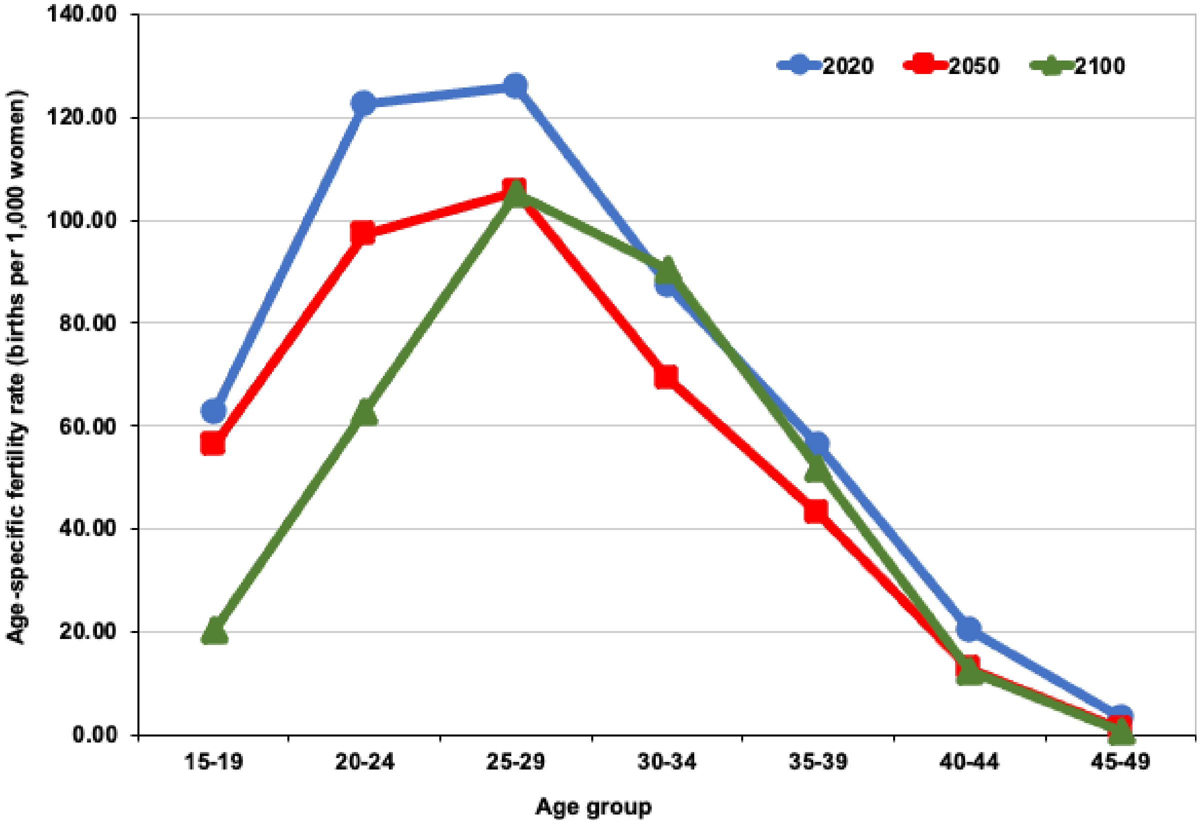
b. Click on icon “Download Data Files.” Or click on menu “Data” and option “Download Center.”

c. Select “Standard Projections” and the “Fertility” topic.

d. Download “Age-specific Fertility Rates (ASFR) by Five-year Age Groups (XLSX).”

e. Search for 2020 data under the “Estimates” tab and for 2050 and 2100 under the “Medium variant” tab.

Figure 1. Age-specific fertility rates in South Africa, 2020, 2050, and 2100



Source: United Nations Population Division (https://population.un.org/wpp/).

Population projection (5 points)

Questions 3.1 and 3.2 are worth 1.5 points each. Question 3.3 is worth 2 points.

3.1. Using lifetable person-years lived entries for the cohort of U.S. women born in 1934 from Table 4.2, calculate subdiagonal entries for a Leslie matrix with 5-year-wide (n=5) age groups. Assume l_0=1,000, f_{fab}=0.4877, ${}_5f_{50}$=0 and ${}_5L_{50}$=4,421.

Table 4.2 A cohort *NRR* from U.S. age-specific rates

x	${}_5f_x$	${}_5L_x$	Babies
0	0	4770	0
5	0	4726	0
10	0	4712	0
15	0.0811	4698	381
20	0.2384	4681	1116
25	0.1969	4662	918
30	0.1033	4637	479
35	0.0313	4604	144
40	0.0046	4561	21
45	0.0009	4503	4
			3,063

3.2. Using age-specific fertility rates for the cohort of U.S. women born in 1934 from Table 4.2, calculate entries in the first row of a Leslie matrix with 5-year-wide (n=5) age groups.

3.3. The matrix A shown below is a Leslie matrix for projecting the female population of Argentina. There are three age groups, each 18 years wide. The starting population for 1992 includes 3.9 million girls aged 0 to 18, 3.3. million women aged 18 to 36, and 2.8 million women aged 36 to 54.

$$A = \begin{pmatrix} 0.551 & 0.556 & 0.037 \\ 0.962 & 0 & 0 \\ 0 & 0.909 & 0 \end{pmatrix}$$

(a) How long is the interval of time covered by a single projection step?

(b) What is the total population of women up to age 54 after one projection step?

(c) What is the total population of women up to age 54 after three projection steps? To what year would this total apply?

(d) At what rate would the population of Argentina be growing according to this projection over three projection steps?