DAT565/DIT407 Assignment 1
Analysis of Sweden's Dependency Ratio and Age Structure

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November 10, 2024

Abstract

This report gives a comprehensive analysis of Sweden's demographic evolution from 1860 to 2022, focusing on the dependency ratio and population age composition. Using the data from the Excel file downloaded from the internet, we calculate and visualize the dependency ratio and proportions of age groups within the total population. Our analysis highlights key demographic trends, explores the implications for the Swedish economy, and draws comparisons with broader global demographic shifts observed in other industrialized nations.

Problem 1: Dependency Ratio Calculation

To calculate the dependency ratio, we could use python codes to divide the dependent population (ages 0-14 and 65+) by the working-age population (ages 15-64) for each year. Firstly, after uploading all the data, we need to handle the data from the file. We could use 'pd.melt()' to transforms the data from "wide format" to "long format," making it easier to group and analyze by year, age, etc. Then we could easily download different data from the clear data set we made before.

The function for calculating could be found in the problem file. The dependency ratio per 100 working-age individuals is computed as follows:

$$\text{Dependency Ratio} = 100 \times \frac{\text{Children (0-14)} + \text{Elderly (65+)}}{\text{Working Age (15-64)}}$$

In this case, we could still use python codes to perform this function and calculate the Dependency Ratio. After the data we have broken down forward, it is easy for us to use codes to calculate each year's dependency ratio and plot a picture. After running the codes, the output is Figure 1.

Figure 1 displays the dependency ratio trend from 1860 to 2022, computed using population data aligned with the World Health Organization's definitions [5].

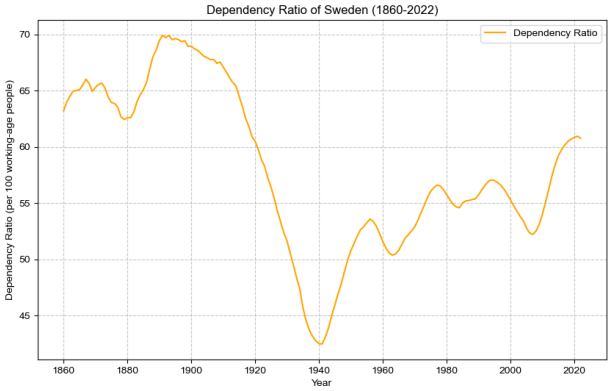

Figure 1: Dependency Ratio in Sweden (1860-2022)

Analysis: The dependency ratio shows significant changes over time:

- **High Dependency in the 19th Century**: Driven by high birth rates.
- **Decline in the Early 20th Century**: Due to falling birth rates and increased industrialization.
- **Post-War Baby Boom**: A temporary rise in dependency due to increased births.
- **Recent Increase**: With the development of technology and the safe environment for people to live, the birth and death rate are gradually getting balanced.

Problem 2: Age Group Proportion

We calculated the proportion of children, elderly, and total dependents within the overall population from 1860 to 2022. This calculation could still use the data we have broken down forward. Then we could draw the figure which contains the children percentage, the elderly percentage and the total dependents percentage in one figure.

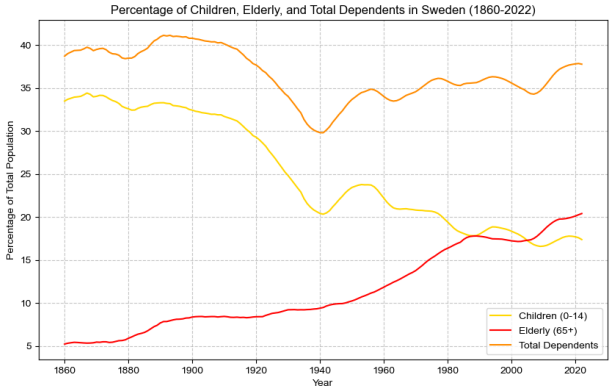

Figure 2: Proportion of Children, Elderly, and Total Dependents in Sweden (1860-2022)

Analysis: Figure 2 illustrates the evolution of age groups:

- **Children's Proportion Decline**: Reflects lower birth rates over time.
- **Elderly Proportion Increase**: Indicates the aging trend in Sweden's population.
- **Total Dependents Increase**: Implies growing economic pressure on the working-age population.

Problem 3: Discussion of Population Trends

The demographic changes in Sweden from 1860 to 2022 reveal several key trends:

- **Impact of Industrialization**: Reduced birth rates and increased life expectancy led to a smaller proportion of children and a larger elderly population. There was several reasons such as urbanization and lower child mortality rates. In agricultural societies, children contributed as workforce for the family. Due to urbanization the economic burden of raising a children increased. Hence, it became less feasible to raise a large number of children [7]. Secondly, due to the advance of medicine and sanitation at the start of the 20th century, child mortality decreased. It was therefore not necessary to have a large family to ensure that some children survived to adulthood [1].
- **Aging Population**: The increase in life expectancy has resulted in a growing share of elderly, consistent with trends in other industrialized nations [8, 9]. With the development of technology and increasing welfare for the elderly [6], the elderly population is gradually expanding. To simplify, people had longer lives to live at that time. From another aspect, Sweden maintain neutrality in both of the World wars. This may lead to a larger working age population at that time. Meanwhile, Sweden took a lot of refugees at that time so the working labor is a large number at that time.

This lead to a very low dependency ratio in 1940. However, this group of people have gradually aged. Considering both the extended lifespan and substantial workforce at that period, the aging population is reasonable.

- **Economic Implications**: A higher dependency ratio places greater economic burdens on the working-age population, necessitating policies such as extended working life and managed immigration [2]. As the elderly population increases, as shown in Figure 2, pension costs and healthcare expenditures rise [4]. The government faces the challenge of either raising taxes or reallocating funds to support these growing expenses. Simultaneously, with declining birth rates, fewer individuals are entering the workforce, creating a dual issue of funding and labor shortages [3]. This trend is common across many industrialized nations. To address the labor gap, governments often turn to increased immigration, aiming to supplement the workforce, particularly in essential service roles such as public transportation, healthcare, and logistics [3]. To summarize when the dependency ratio has been high at the begining of the 20th century due to the large amount of children in the population. On the other hand, during the begining of the 21st century we have seen an increase of the dependecy ratio due to the increase of eldery people.

These trends align with broader demographic patterns observed globally in industrialized countries which we could see from the following figure, where declining birth rates and increased life expectancy lead to challenges in supporting an aging population.

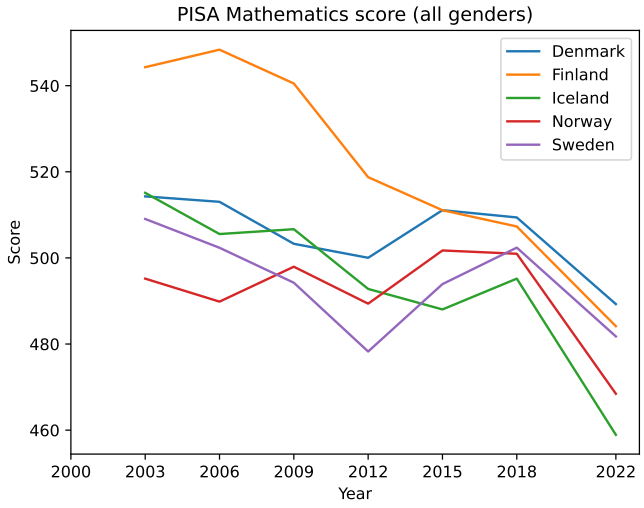

Figure 3: pisa mathematics in nordic countries

References

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ity Weekly Report. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm4838a2.htm. Sept. 1999.

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[6] Göran Sundström. *The Swedish Model of Elderly Care and Services – Trends, Current Status and Challenges for the Future.* This document describes Sweden's policies in response to an aging population and analyzes the challenges of aging on the Swedish welfare system. 2009.

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A Python Code for Analysis

The following code was used for data processing and analysis:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
plt.rcParams['font.sans-serif'] = ['Arial']
plt.rcParams['axes.unicode_minus'] = False
data = pd.read_csv('D:/DAT565/
    swedish_population_by_year_and_sex_1860-2022.csv')
data_long = pd.melt(data, id_vars=["age", "sex"],
    var_name="year", value_name="population")
```

```
data_long["year"] = data_long["year"].astype(int)
data_long["age"] = data_long["age"].replace("110+",
    110).astype(int)
children = data_long[(data_long["age"] >= 0) & (
    data_long["age"] <= 14)].groupby("year")["
    population"].sum()
labor_force = data_long[(data_long["age"] >= 15) & (
    data_long["age"] <= 64)].groupby("year")["
    population"].sum()
elderly = data_long[(data_long["age"] >= 65)].groupby(
    "year")["population"].sum()
dependency_ratio = 100 * (children + elderly) /
    labor_force
plt.figure(figsize=(10, 6))
plt.plot(dependency_ratio.index, dependency_ratio.
    values, label='Dependency Ratio', color='orange')
plt.xlabel('Year')
plt.ylabel('Dependency Ratio (per 100 working-age
    people)')
plt.title('Dependency Ratio of Sweden (1860-2022)')
plt.legend()
plt.grid(True, linestyle='--', alpha=0.7)
plt.savefig('dependency_ratio_sweden.png')
plt.show()
total_population = data_long.groupby("year")["
    population"].sum()
fraction_children = children / total_population * 100
fraction_elderly = elderly / total_population * 100
fraction_dependents = (children + elderly) /
    total_population * 100
plt.figure(figsize=(10, 6))
plt.plot(fraction_children.index, fraction_children.
    values, label='Children (0-14)', color='gold')
plt.plot(fraction_elderly.index, fraction_elderly.
    values, label='Elderly (65+)', color='red')
plt.plot(fraction_dependents.index,
    fraction_dependents.values, label='Total Dependents
    ', color='darkorange')
plt.xlabel('Year')
plt.ylabel('Percentage of Total Population')
plt.title('Percentage of Children, Elderly, and Total
    Dependents in Sweden (1860-2022)')
plt.legend()
plt.grid(True, linestyle='--', alpha=0.7)
plt.savefig('age_group_percentage_sweden.png')
plt.show()
```