

# Effect of Ageing on Economy and Social Well-Being in Germany, Japan and the United States

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## 1. Abstract

This paper describes the design of a software simulation to predict the effects of an ageing population on public retirement funds in Germany, Japan and USA by the year 2050. By 2010 Baby Boomers will begin to retire adding to the already retired population causing a tremendous increase in the number of non-working people.[6] While the number of working people will decrease over the next fifty years, the productivity and the Gross National Product will also decrease. This paper focuses on how the population ageing in each country may affect the economy. Using GlobeSight software and Microsoft Excel for simulation, we project problems in government funding for retired people. These problems will occur due to the change of many demographic factors in the future such as: birth rates, fertility rates, number of working people and the gross national product. Data acquired from government documents are inputs for our model. After developing graphical models from this data, we predict whether each country can economically support the growing number of retired people by the year 2050, which is our output.

## 2. Introduction

The purpose of this study is to design and understand methods for alleviating the effects of population ageing on the economies of Germany, Japan and the US. In approximately fifty-years, Baby Boomers of these countries will have retired leading to a drastic imbalance of working people to retirees. Approximately half of the population in these three countries will consist of retirees. The dramatic increase of proportion of people of age 65 and above has alarmed the need to enlarge pension funds in the government's expenditure.

Since the last 100 years, retirees have enjoyed their pension funds.[8] However, now the problem lies in government allocation of pension funds due to the growing number of elderly people. Above all, the increasing number of elderly people will drain government funds.

To understand the economic effects of an ageing population, we design a mathematical model to project future population and economic trends. These trends allow us to decipher whether each government can support its elderly population by the year 2050

## 3. GlobeSight 1.11

GlobeSight 1.11 is a software simulation used to project and predict future trends depending on data inputted into its database. GlobeSight has been used for its capability to show realistic trends and projections by many institutions such as the Geneva Institution and the Systems Control Engineering Department of Case Western Reserve University.

We use GlobeSight to predict trends of ageing population and economies of Germany, Japan and the United States. In order to use GlobeSight as a tool for modeling, an XML file first stores all variables and respected definitions. A Java file is also incorporated into GlobeSight to include all variables in mathematical equations.

The following equations are used by GlobeSight to calculate those fields necessary to our purpose of projecting future population and economic trends:

### (a) Total Population of a region (popt)

$$\text{popt}[r] = \sum_{j=0}^{100} \text{popc}[r][j]$$

**(b) Gross National Product (GNP)**

$$GNP[r] = GNP\_b[r] * GNP\_m[r]$$

**(c) Gross National Product per Capita (GNP\_PC)**

$$GNP\_PC[r] = GNP[r] / Popt[r]$$

**(d) Working Population (WRK\_Pop\_b)**

$$WRK\_Pop\_b[r] = \sum_{j=18}^{65} popc [r ][j] *$$

**(e) Productivity (Prod\_Pop)**

$$Prod\_Pop[r] = GNP[r] / WRK\_Pop[r]$$

(Indicator: r = region, j = age cohort)

**4. Population Modeling**

Population modeling examines changes taking place in Germany, Japan and the United States over the next fifty years for all age cohorts. For example, at present, the United States has 47 million retirees; by 2030, the US will have over 70 million retirees. This significant increase in elderly population is due to Baby Boomers retiring starting from 2008.[6] By projecting future trends of aging population, we relate changes in birthrates and fertility rates to changes in overall population cohorts. In Japan, birthrates have declined for the past quarter century. In a few years, this phenomenon will cause the number of older people to be much greater than the number of working people (18-65). Contrary to trends in the past where younger people have been the dominant sector of the population, now, older people are taking the lead as the largest sector of population in most developed countries.

**5. Economic Modeling**

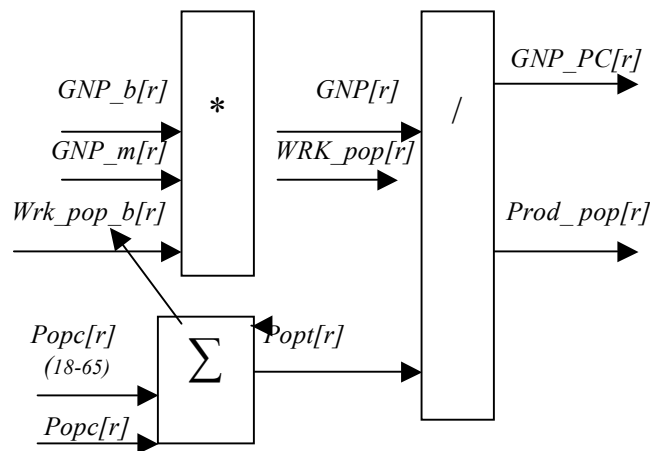
The economic model shows trends of factors such as gross national product, working population, and productivity of each country. By evaluating how many people will be working in the future, how the economy will be performing in the future in terms of its GNP, and how the productivity (the amount of money contribution to the GNP per person) will be increasing or decreasing, we identify whether each country can support its growing number of retirees.

This economic model is based off the population model. By looking at the population between

the age cohort of 18-65, we link the population model to the economic model. This specific age cohort is the working population used in the economic model.

Undoubtedly, Japan, Germany and the United States have different pension plans; however, these three countries are well known for generous pension contributions [2].

Nevertheless, our main goal is not to determine how to improve each country's retirement system, but to project the amount of money spent for retirement plans in each respective country and to determine which country will be economically affected first.



**Figure 1: Block Diagram of Economic Model**

**6. Data**

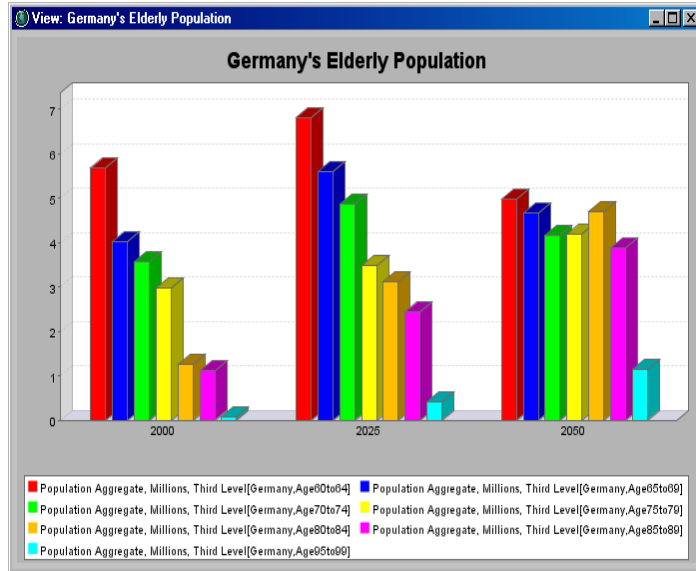
In order to project population and economic trends from 2000 till the year 2050, we need data for all these years. However, since we are only in 2004, factual data does not exist. The United Nations Population Division though has population data till year 2050. After retrieving this data and inputting it into GlobeSight's database, we make population projections till 2050. On the other hand, economic data came from The World FactBook published by the Central Intelligence Agency and the Statistical Abstracts published by the US Census Bureau. We use this data to project economic trends in our model.

Using the Gross National Product (GNP) value of the year 2000 as a starting point in our projection, we chose different growth rates such as 2.5% or 2.0%

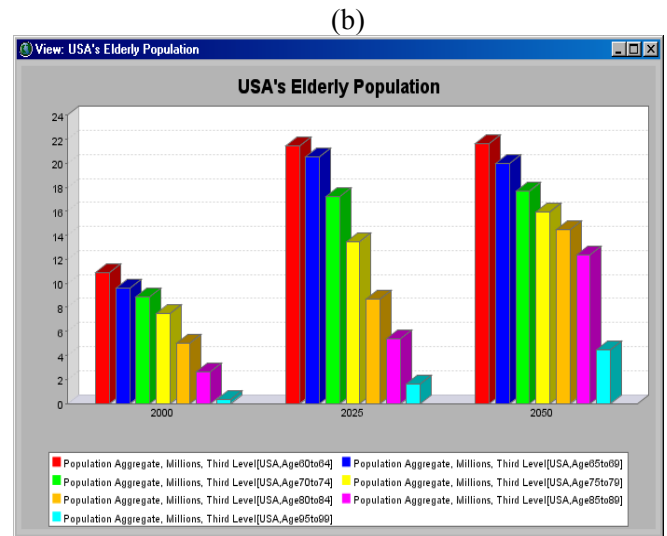
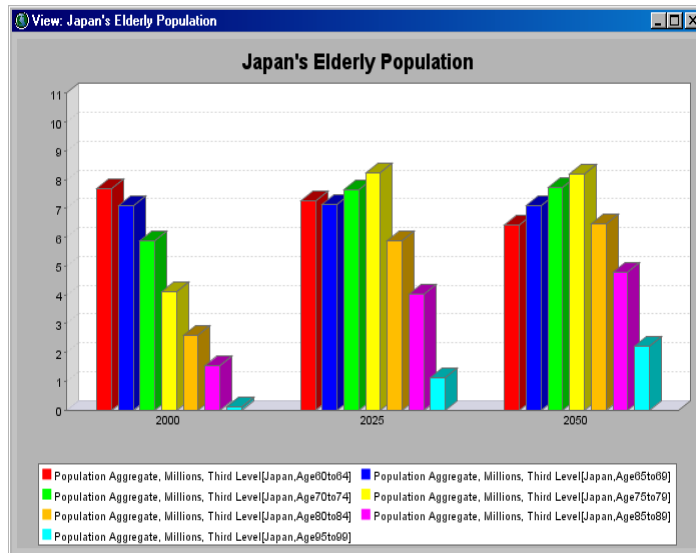
growth rate to show how the GNP fluctuates from 2000 till 2050. GNP values for Germany and Japan exist in different currencies. To make our data practical and useful, we convert the currencies of Germany and Japan into dollars by using an online currency converter that uses the most recent exchange rates.[9]

## 7. Results

The following graphs show population simulation results:

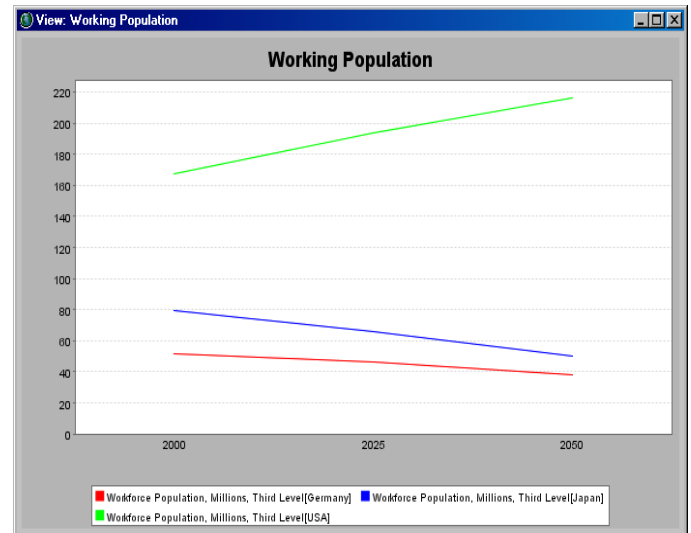


(a)



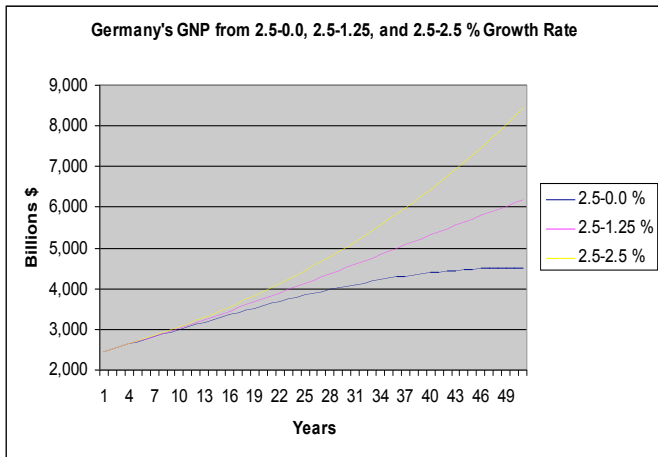
(c)

**Figure 2: Population Growth Of Ages 60-99 from Year 2000 till Year 2050 (a) Germany's Elderly Population Growth (b) Japan's Elderly Population Growth (c) USA's Elderly Population Growth**

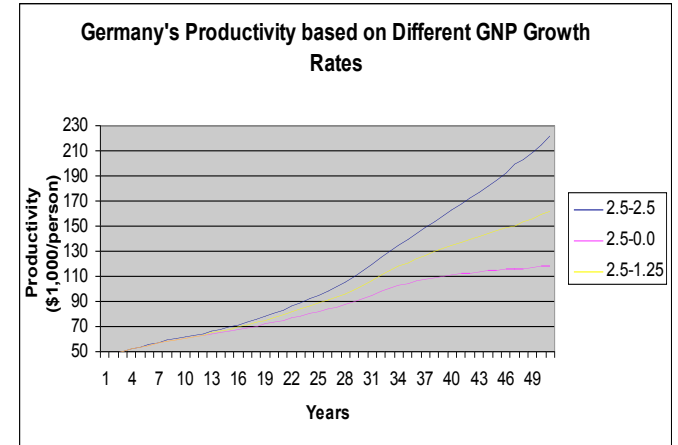


**Figure 3: Projection of Working Population for United States, Japan, and Germany from Year 2000 till Year 2050 in millions (US-green, Japan-Blue, Germany-Red)**

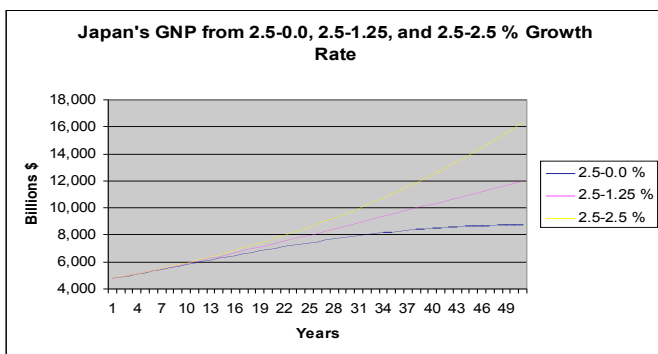
The following graphs show economic simulation results:



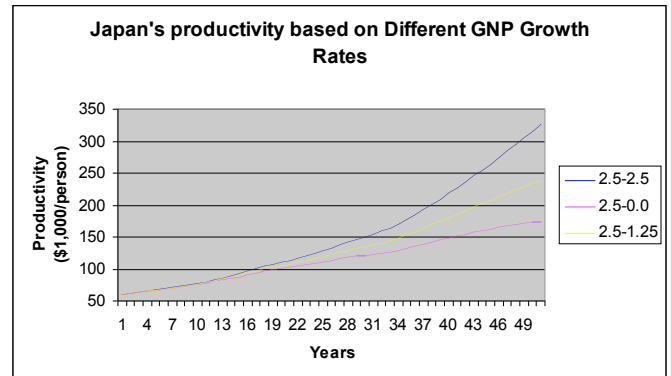
(a)



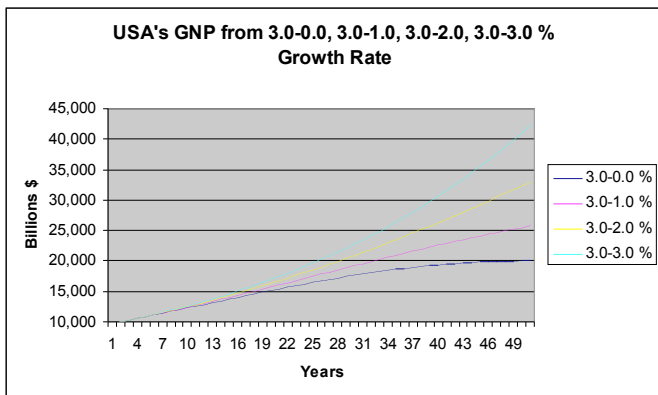
(a)



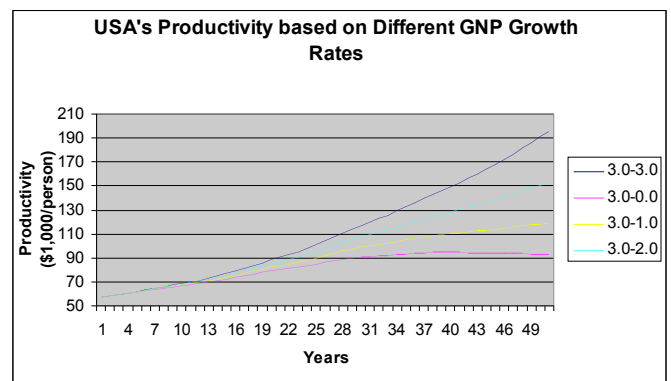
(b)



(b)



(c)



(c)

Figure 4 : Gross National Product Projections based on different Growth Rates from Year 2000 till 2050 (a)

Figure 5 : Productivity Projections based on different GNP Growth Rates from Year 2000 till 2050 (a)

Germany's Gross National Product (b) Japan's Gross National Product (c) USA's Gross National Product

Germany's Productivity (b) Japan's Productivity (c)  
USA's Productivity

**Table 1:**  
**Life Expectancy**

Germany	Japan	USA
78.42	80.93	77.14

Source: Year 2003 CIA

**Table 2:**  
**Percent Increase of Elderly People  
from year 2000-2050**

Germany	Japan	USA
48.49	56.82	151.38

Source: United Nations

**Table 3:**  
**Dependency Ratio  
(Number of elderly supported by 100 working  
people)**

	Germany	Japan	USA
<b>1960</b>	16.0	9.5	15.4
<b>1990</b>	21.7	17.1	19.1
<b>1995</b>	22.3	20.3	19.2
<b>2000</b>	25.0	27.0	21.0
<b>2010</b>	30.3	33.0	20.4
<b>2025</b>	36.0	47.0	33.0
<b>2030</b>	49.2	54.5	36.8

Source: United Nations

**Table 4:**  
**Projections of Pension Expenditures of Public  
Pension Funds (% GDP)**

	Germany	Japan	USA
<b>1995</b>	10.0	5.7	4.4
<b>2000</b>	11.1	6.5	4.3
<b>2010</b>	11.0	7.5	4.2
<b>2020</b>	12.3	8.9	5.2
<b>2030</b>	17.5	14.1	7.0
<b>2050</b>	18.4	14.4	7.4

Source: OECD

**Table 5:**  
**Net Immigration from 1995-2000**

Germany	185,000
Japan	56,000
USA	1,250,000

## 8. Discussion

This section discusses some of the many factors that contribute to the future of a country's economy. In terms of life-expectancy (see Table 1), Japan has the highest life expectancy followed by Germany and then the United States. Due to this, retirees in Japan will be living the longest after retirement, followed by Germany and the US. Consequently, as a country spends more money to support retirees now living longer than ever before, Japan will have the most difficulty to support the elderly.

From Table 2 we see which country faces the largest increase in elderly people. The USA comes in first with 151.38% increase, followed by Japan and then Germany with 56.82% and 48.89% respectively.

Since the United States has the largest increase in elderly population, one may assume that US is the first country affected by ageing population. However, Figure 3 shows that the working population for the US is increasing over the next 50 years, whereas the working population for Germany and Japan is decreasing. With an increasing number of people in the workforce, the US will be better off than Germany and Japan to support its elderly. In addition, Japan's working population declines at a faster rate than that of Germany's. This rapid depletion of Japan's working population gives us an insight that Japan has the least potential to support its elderly people.

Another factor to consider is Dependency Ratio, shown in Table 3. Dependency ratio is defined as the number of elderly people supported by every 100 working people. Among these three countries, Japan has the highest dependency ratio, once again showing signs that Japan's economy will be affected not only first, but also the most severe.

Germany, Japan and the US have similar systems to fund retirees. This system, known as PAYGO (Pay-As-You-Go), requires today's workers to contribute to pensions funds for today's retirees through taxation. [7]

In Table 4, trends of pension expenditures as a percent of Gross Domestic Product show that in Year 2050, Germany will spend the greatest proportion of its GDP on Pension, followed by Japan and then the US with the least amount. Since the US is not spending as much money as Germany, the US will not be affected in manipulating its funds to support the elderly whereas Germany and Japan will be compelled to find other funds and resources.

The last factor taken into consideration is Table 5-Immigration. Many economists believe that increasing immigration can reduce the affect of ageing population on a country's economy.[4] The United States is known for its successful immigration policies due to its greater labor-market flexibility as can be seen from Table 5.[4] Germany too has tried to increase its immigration; however, they have not been successful for reasons of language barrier and discrimination. [4] With a large number of immigrants contributing to the working population, the US has an advantage over Japan and Germany in easing its economic problems caused by the ageing population.

## 9. Conclusion

From graphical representations and Tables 1-5, we see an ageing problem affecting the economies of Germany, Japan and the United States within the next fifty years. Specifically, Japan's economy will be affected the greatest in the shortest amount of time due to the large increase in elderly population and a decrease in working population along with a longer life expectancy and the lowest immigration rate. After Japan, Germany follows due to the same factors but at a slower rate than Japan. In last place comes the United States. With the strongest economy in the world and an increasing working population over the next fifty years along with an open door immigration policy, the US can delay the effects of population ageing on the economy.[5] Even when the US faces similar problems, they will not be as severe as those of Germany and Japan. In Tables 3 and 4, by 2030, all three countries will start to face significant economic problems regarding pension expenditure.

Some factors not included in our study due to time constraints and availability of data are the presence of immigration trends in each country. Immigration has an affect on the working population and the GNP of a country; due to this our model may not be as realistic as

possible, but still sufficient to show future trends reflecting problems caused by an ageing population.

Another factor we did not consider is inflation mainly because it is very difficult to predict future inflation rates and the effect it will have on variables such as GNP.

Also, our working population encompasses the entire age cohort of 18-65; however, everyone between this age may not necessarily be working. Seeking numerical data of people working between the age of 18-65 is difficult. Therefore, we use the entire age cohort of 18-65 as our working population because they are the people eligible to work.

Although a few variables and factors are not considered as part of this study and may seem essential to understand future economic trends, we decide not to consider them mainly because of time and because of the complexity of this study.

## 10. Acknowledgment

We would like to thank Professor Sreenath, Professor Mesarovic, Professor Merat and Craig Atzberger for all their help and guidance in developing and finishing this study. Without their knowledge and assistance, this paper would not be possible.

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