SIMULATION MODEL OF JAPANESE WELFARE ANNUITY SYSTEM

Toshiro Shimada, Meiji University, Tokyo, Japan
Saburo Kameyama, Chuoo University, Tokyo, Japan
Akira Uchino, Senshuu University, Tokyo, Japan
Kinya Machida, Surugadai University, Tokyo, Japan
Minoru Watanabe, Japan Productivity Center, Tokyo, Japan

Abstract

Japanese old age population is gradually increasing and this tendency weakens economic conditions of Japanese welfare annuity system. Therefore it is important for us to study future conditions of this system.

This model contains 4 sectors: Demography, total premiumm income, total pension expenditure and reserve of the welfare annuity system.

The demographic sector covers populations of 5 three-year age groups under 14 years of age and 13 five-year age groups above 15 years of age. This sector was first formulated for a simulation model of dental deseases[2] and is now appllied to this model. Total premium income for the welfare annuity system is the sum of premiums of workers, employer contribution and government contribution, for which populations of five-year age groups are used. Total pension expenditure is the sum of base pensions and earning related pensions. Here is used population of 60-64 age group. Total premiums plus interest income of the reserves of the welfare annuity system minus total pension expenditures flow into the reserves of the welfare annuity system.

The length of the simulation is 63 years from 1963 to 2025.

This study is a research project of the Japan Productivity Center.

Introduction

Annuity calculation is simple. Only premiums and pensions need to be estimated. However, the premium rate in the future used to be changed by government policies and may not fit our economic conditions. So in this model the premium rate is calculated from the model itself according to the reserves of the annuity system.

1. Model for Welfare Anuuity System

1. 1. Parts composing the model

This model contains 4 sectors: demography, total premium income, total pension expenditures and the reserves of the welfare annuity system. In each sector we deal with the whole of Japan.

1. 2. Demographic Sector

The demographic sector covers populations of 5 three-year age groups under 14 years of age and 13 five-year age groups above 15 years of age. The former are the groups 0-2, 3-5, 6-8, 9-11 and 12-14 years of age, and the latter are the groups of 15-19, 20-24, ..., (70-74) and 75 years of age. Population of each age group is a level depending on the rates of entering and leaving. The first age group Z0 is entered by births and left by aging out and deaths in the age group. Other age groups Z3, Z6, ..., Z75 are entered by aging out of the previous age group and left by either aging out of this age group or through death.

The flow diagram of this sector is shown in Fig.1.

2. Welfare Annuity System Sector

As shown in Fig.2, premiums of persons insured of 2nd industry and tertiary industry, employer contribution, government contribution and interest income of pension reserves flow in, while basic pensions and earning related pensions flow out. The difference between the inflow and the outflow is to be added to the cash balance of the pension reserves.

In Fig.2 numerals below each variable correspond to the equation number described later.

In Fig.2 two negative feedback loops are seen as follows.

Premium rate PRR ---- sum of premiums of persons insured, 2nd industry PRWA2 ---- total income of the annuity system TPEI --- reserve of welfare annuity system RWAS ---- ratio of premium reserve to TPEE RPR ---- PRR

Total government contribution TGC ---- TPEI ---- RWAS ---- RPR ---- TGC

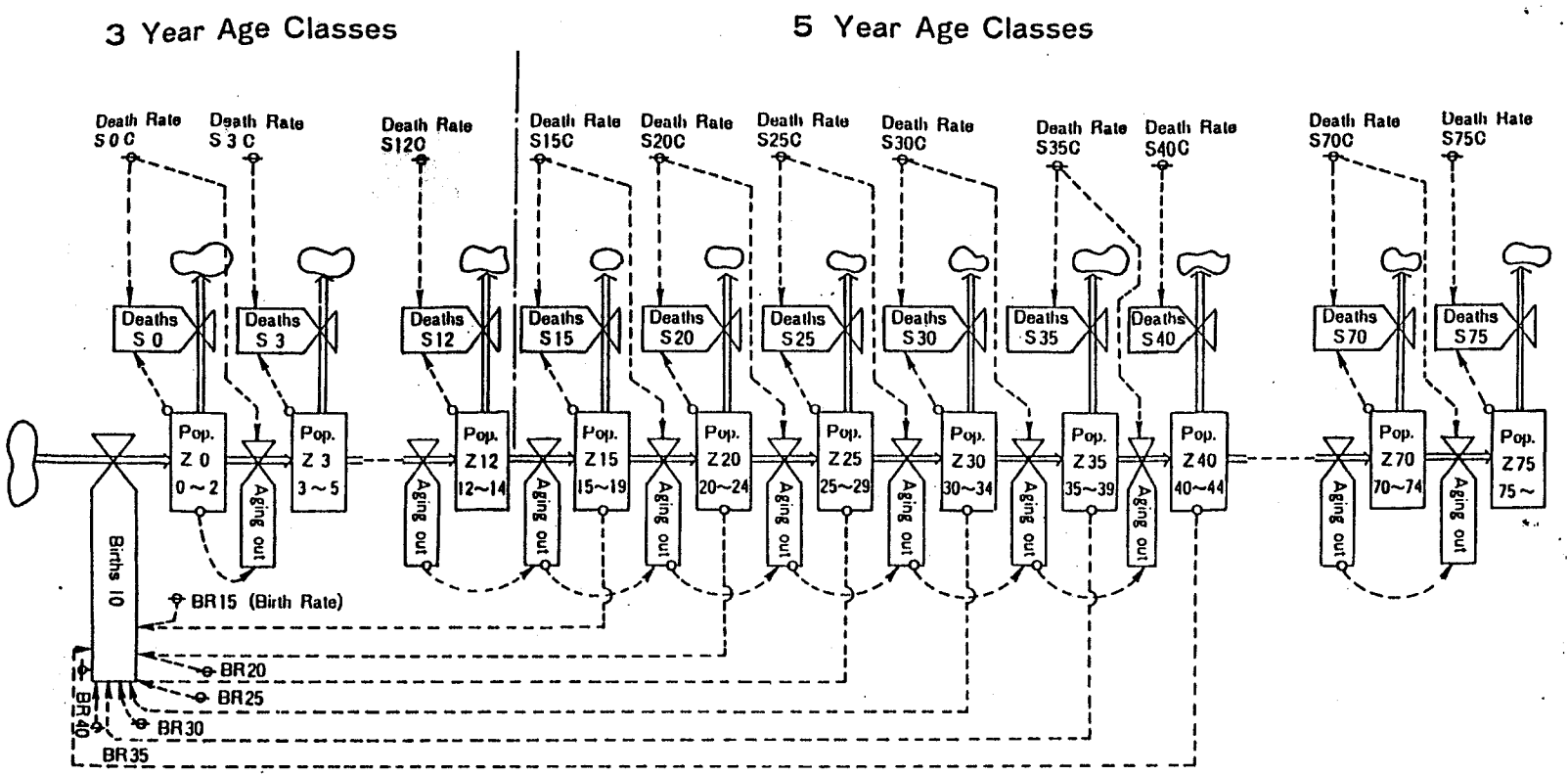

Fig.1 Flow Diagram for Demographic Sector

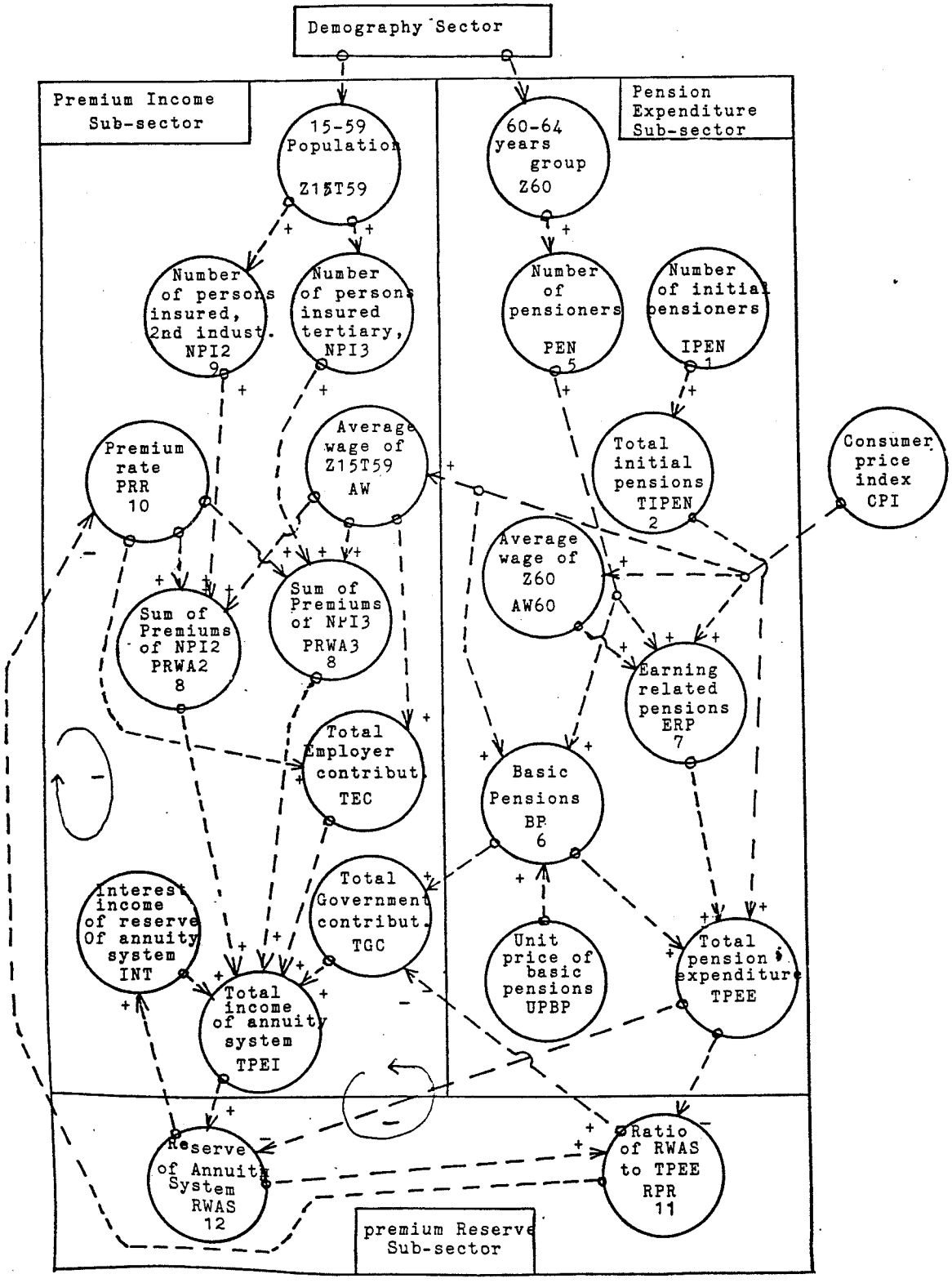

Fig.2 Welfare Annuity System Sector

From these loops, when the ratio of the premium reserves to the total pention expenditures goes below a certain value, the premium rate and the government contribution are to be raised.

2. 1. Pension Expenditure Sub-sector

We divide pensioners into 2 categories. They are the number of pensioners at the beginning of 1963 and those who become eligible for the pension each year.

Survivals of intial pensioners at the beginning of 1963 are

IPEN.K=IPEN.J+(DT)(DIPEN.JK +0) (1,L)

IPEN =378000 (N)

DIPEN.KL =(IPEN.K)(DRIPEN.K)

DRIPEN =an assumed time series

IPEN remaining of Initial PENsioners at the beginning of 1963 (Men)

DIPEN number of yearly Deaths of IPEN (Men/Year)

DRIPEN Yearly Death Rate of IPEN (1/Year)

The number of pensioners at the beginning of 1963 decreases in proportion to their yearly death rate.

This decreasing number is IPEN in the equation (1), a level equation.

TIPEN.K=(IPEN.K)(AWIPEN.K) (2)

TIPEN Total amount of the pensions of IPEN (¥1000/Year)

AWIPEN Average amount of pensions (¥1000/Man/Year)

New pensioners will be qualified yearly.

The sum of pensioners newly becoming eligible for the pension from 1963 is obtained by the next level equation.

PEN.K=PEN.J +(DT)(PENO1.JK −DPEN.JK) (3,L)

PEN=0 (N)

PENO1.KL =(RPENO1.K)(Z60.K) ×1000 (4,R)

DPEN.KL=(PEN.K)(S60.K) (5,R)

PEN sum of PENsioners newly becoming eligible for the pension from 1963 (Men)

PENO1 number of PENsioners of current year (Men/Year)

Z60 60-64 population (1000 Men)

RPENO1 Rate of new PENsioners (1/Year)

DPEN yearly Deaths of PEN (Men/Year)

Now basic pensions are calculated as follows.

$$BP.K = PEN.K * APER.K * UPBP.K \quad (6)$$

BP Basic Pensions (¥1000/Year)

PEN number of PENsioners (Men)

APER Average PERiod (Months)

UPBP Unit Price of Basic Pensions (¥1000/Man/Month)/Year

For the basic model, average period APER is assumed to be 210 months and unit price UPBP is set equal to a decreasing time series as the same as government data.

Next is earning related pensions.

$$ERP.K = PEN.K * AW60.K * RERP.K * APER.K \quad (7)$$

ERP Earning Related Pensions (¥1000/Year)

PEN number of PENsioners (Men)

AW60 Average Wages for 60-64 age group (¥1000/Man/Month)

RERP Rate to ERP (1/Year)

APER Average PERiod (Months)

Average Wages for 60-64 age group AW60 is assumed to be 1.25 times the average wages for persons insured under 60 years old AW which is assumed to be a linear regression function of the consumer price index CPI. CPI is a table function, which is set equal to the actual data until 1989, and from 1990 is assumed 2% rise.

the rate to earning related pensions RERP is also a time series, of which the values are given by the government.

Now the total pension expenditures TPEE are the sum of the total amount of pensions of initial pensioners TIPEN, the basic pensions BP and the earning related pensions ERP.

2. 2. Premium Income Sub-sector

Income rates are premiums of persons insured of 2nd industry and tertiary industry, employer contribution, government contribution and the interest income from the pension reserves.

Premiums of persons insured are obtained as follows.

$$PRWA.K = (NPI2.K + NPI3.K)(AW.K)(12)(PRR.K) \quad (8)$$

PRWA yearly sum of PRemiums of persons insured (¥1000/Year)

NPI2, NPI3 Number of Persons Insured, 2nd and tertiary

industry (Men)

AW Average Wages of persons insured less than 60 years old (¥1000/Man/Month)

PRR PRemium Rate (1/Year)

The number of persons insured, for example, NPI2 can be calculated as follows, using the population for 15-59 age groups Z15T59.

NPI2.K =RNPI2.K * Z15T59.K *400 (9)

RNPI2 Ratis of NPI2 to Z15T59 (Unitless)

RNPI2 is assumed to be an increasing time series.

Next is the premium rate PRR, which is a level function and is assumed as follows.

PRR.K =PRR.J +(DT)(PRRI.JK+0) (10,L)

PRRI.KL =PRR.K * CLIP(0, CI, RPR.K, CRPR)

RPR.K =RWAS.K/TPEE.JK (11)

PRR PRemium Rate (1/Year)

RPR Ratio of Premium Reserves to TPEE (Years)

RWAS Reserves of Welfare Annuity System (¥1000)

If the reserves of the welfare annuity system RWAS become less than a certain number CRPR times the total pension expenditures TPEE, then the premium rate PRR may be raised by a certain percent C1. This calculation may be done by the above equations.

In the base model, the total employer contribution TEC is assumed as the same as the premiums of persons insured PRWA, and the government contribution TGC is the basic pension/3.

Now the total income of the annuity system TPEI is the sum of the premiums of persons insured PRWA, the total employer contribution TEC, the government contribution TGC, and the interest income of the reserves of the welfare annuity system RWAS, which are easily given by the next level equation

RWAS.K =RWAS.J+(DT)(TPEI.JK−TPEE.JK) (12,L)

RWAS Reserves of Welfare Annuity System

3. Simulation Results

Specifications for the simulation are as follows :

1. The length of time for the simulation run was 62 years from 1963 to 2025.
2. The time interval between computations of the equations (DT) was one year.

Conditions among all simulation runs are as follows :

1. Pensions are to be paid to pensioners more than 60 years old.
2. The interest rate of the reserves of the welfare annuity system is assumed to be 5.5%.

3. 1. Basic Run

1. After 1990, the consumer price index is assumed to rise 2% annually.
2. The premium rate is as the same as government data.
3. The government contribution is assumed to be 33% of the base pensions.

This run is seen in Fig. 3.

3. 2. Run of Premium Rate Change

When the ratio of the reserves of the welfare annuity system to the total pension expenditures becomes less than 6.0 until 2031 and 1.0 after then, the premium rate is to rise 16% from 1990 to 1994 and 7-8% after 1995. Fig. 4 shows this run. By this run, the premium rate may be made comparatively less than the government plan.

4. Conclusion

This model consists of 4 sectors; demography, total premium income, total pension expenditures and the reserves of the welfare annuity system. The method of calculation is simple, but from feedback loops in this model we can deal with premium rate change. We can not expect this merit by other methods than System Dynamics.

References

1. Shimada Toshiro, Annuity Simulation , The Bulletin of Arts and Seience, Meiji University, pp34-52, 1976.
2. Shimada Toshiro, K. Fukushima, H. Mizushima, K. Machida and A. Uchino, A Simulation Model for Dental Diseases , Proceedings of the 1987 International Conference of the System Dynamics Society, pp476-482, 1987.

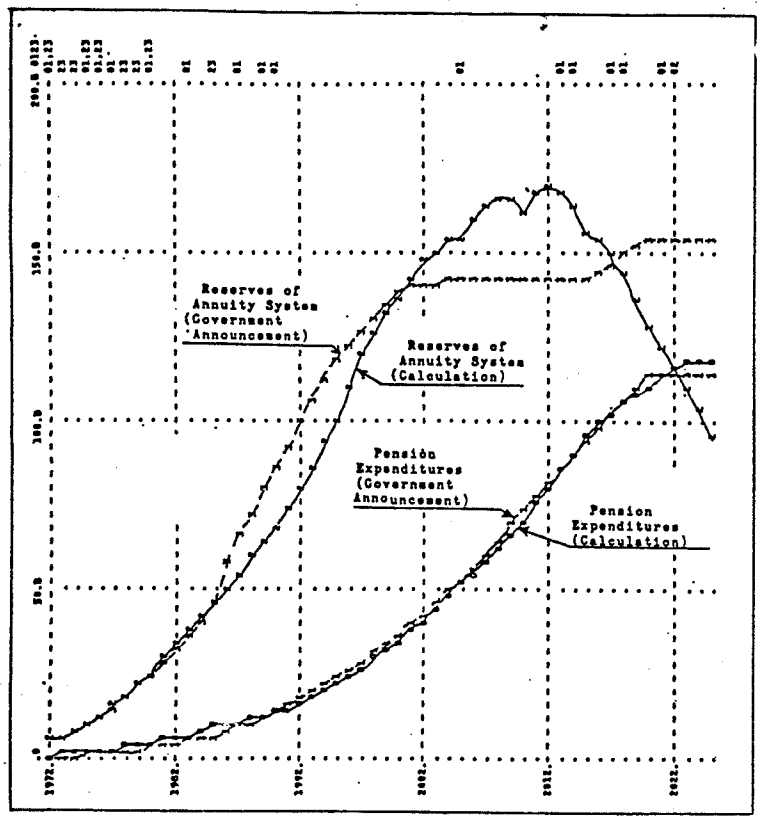

Fig.3 Basic Run
Reserves of Annuity System, Pension Expenditures.

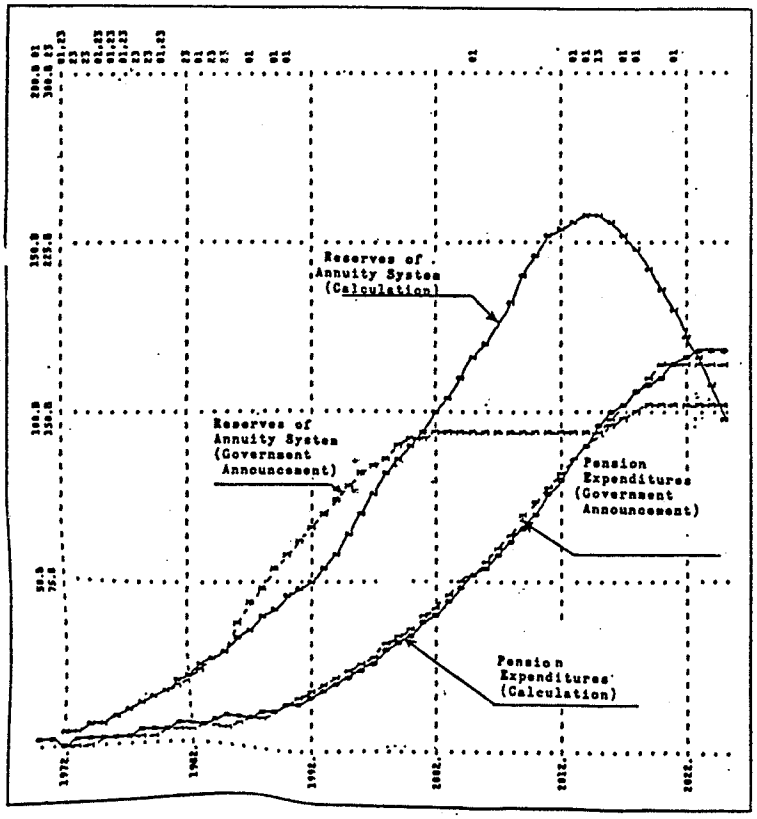

Fig.4
Premium Rate Change