A Simulation Model of Deaths in Japanese Working Men by Major Groups of Industry

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ABSTRACT

An employment rate in Japan had risen from 2.0% in 1980 to 5.4% in 2002, and fluctuates between 4 and 5% in these years. Higher death rate in unemployed people is one of the public health issues. This study aimed to develop a simulation model to evaluate an impact of unemployment on deaths among Japanese men. Aging chains were constructed by 5-year age groups between 30 and 59 years separately for primary, secondary and tertiary industries and unemployment, and populations for each age group and industry between 1980 and 2010 were optimized to actual numbers in the Report of Vital Statistics: Occupational and Industrial Aspects published by the Ministry of Health, Labour and Welfare every 5 years. Though a total number of deaths will decrease by 28% from 2010 to 2020, the percentage of deaths in unemployed men will increase from 53% to 62% due to the increasing number of unemployed men.

Keywords: ageing chain, primary industry, secondary industry, tertiary industry, unemployment

INTRODUCTION

An employment rate in Japan had risen from 2.0% in 1980 to 5.4% in 2002, and fluctuates between 4 and 5% in these years (Ministry of Internal Affairs and Communications, 2013). The death rate is higher in unemployed people than that in those employed (Ministry of Health, Labour and Welfare, 2013), and an increased number of unemployed people could lead an increase of deaths in working population in Japan. Thus, a higher death rate in unemployed people is one of the major public health issues.

System dynamics is suitable for simulation of population dynamics, but its use in public health is very limited in Japan. This study aimed to develop a simulation model of deaths in Japanese working and unemployed men by major groups of industry and unemployment and especially to evaluate an impact of unemployment on deaths among Japanese men.

MODEL STRUCTURE

A model was developed for simulating dynamics of Japanese men aged 30 to 59 years from 1980 to 2020. It consists of aging chains for four major groups of industry: primary industry (PI), secondary industry (SI), tertiary industry (TI) and unemployment (UE). Aging chain of each major group of industry consists of 6 5-year age groups. A basic structure and an overall structure of the models are shown in Figure 1 and Figure 2, respectively. Vensim DSS 6.1 was used to develop and optimize the model.

Unit of aging chains

A unit of aging chains consists of one stock and four flows: one inflow and three outflows. A stock represents male population in 5-year age group (for example, men in primary industry aged 35 to 39: PI3539) at a given year, and the actual population of each age group in 1980 is assigned as initial value.

The one inflow directs from the neighboring younger age group to each age group (for example, an inflow PIto35, from PI3034 to PI3534), and a fifth of population in a younger age group is assigned to flow into each age group. As for the inflow into the youngest age group (for example, PIto30), a fifth of male population of each industry aged 25 to 29 is given every 5 years by a lookup variable (for example, PIto30t) and time.

One outflow is from each age group to the neighboring older age group (for example, an outflow PIto35, from PI3034 to PI3539), which is identical to the inflow from a neighboring younger age group to each age group we defined above.

Another outflow is for deaths in each age group (for example, deaths PI3539D from PI3539). Actual death rates in the Report of Vital Statistics: Occupational and Industrial Aspects published by the Ministry of Health, Labour and Welfare (2013) every 5 years are given by a lookup variable (for example, PI3539drt) and time through an auxiliary variable (for example, PI3539dr) to an outflow. In addition, death rates of the highest age group of major groups of industry, that is, 55 to 59 years, are linearly extrapolated to 2020 using a difference in death rates between 2005 and 2010, and death rates of other age groups were estimated by reproducing the same ratios to those for the oldest age groups in 2010 (Figure 3).

The other outflow is for migrations from each age group (for example, migrations PI3539M from PI3539). Ratios of differences in actual populations between neighboring 5-calendar-year intervals to actual populations in older calendar years (for example, (1980 population – 1985 population)/1980 population) are given by a lookup variable (for example, PI3539mrt) and time through an auxiliary variable (for example, PI3539mr) with a multiplier (for example, PI3539a). A negative difference means that actual direction of migrations is inflow into the population of the age group. A multiplier was used for optimization.

Optimization

An optimization was performed using multipliers of migrations of each age group to actual populations of each age group in primary, secondary and tertiary industries and unemployment in reference mode. The reason for optimization being performed separately by major groups of industry was that little information was obtained for numbers of migrations between major groups of industry.

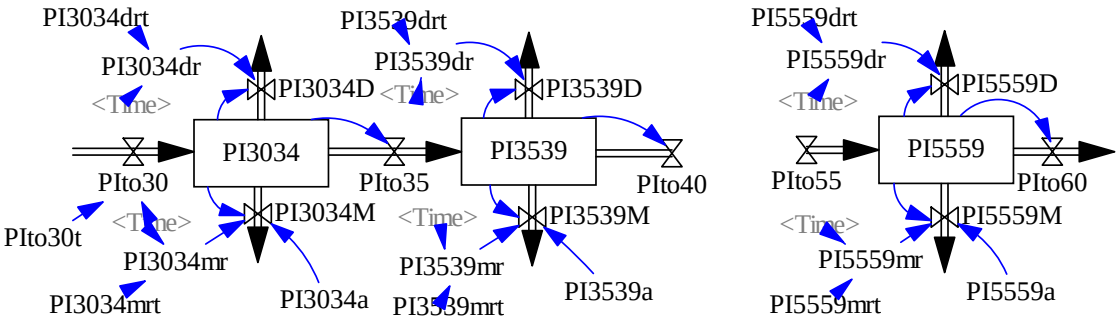

Figure 1. Basic structure of the model

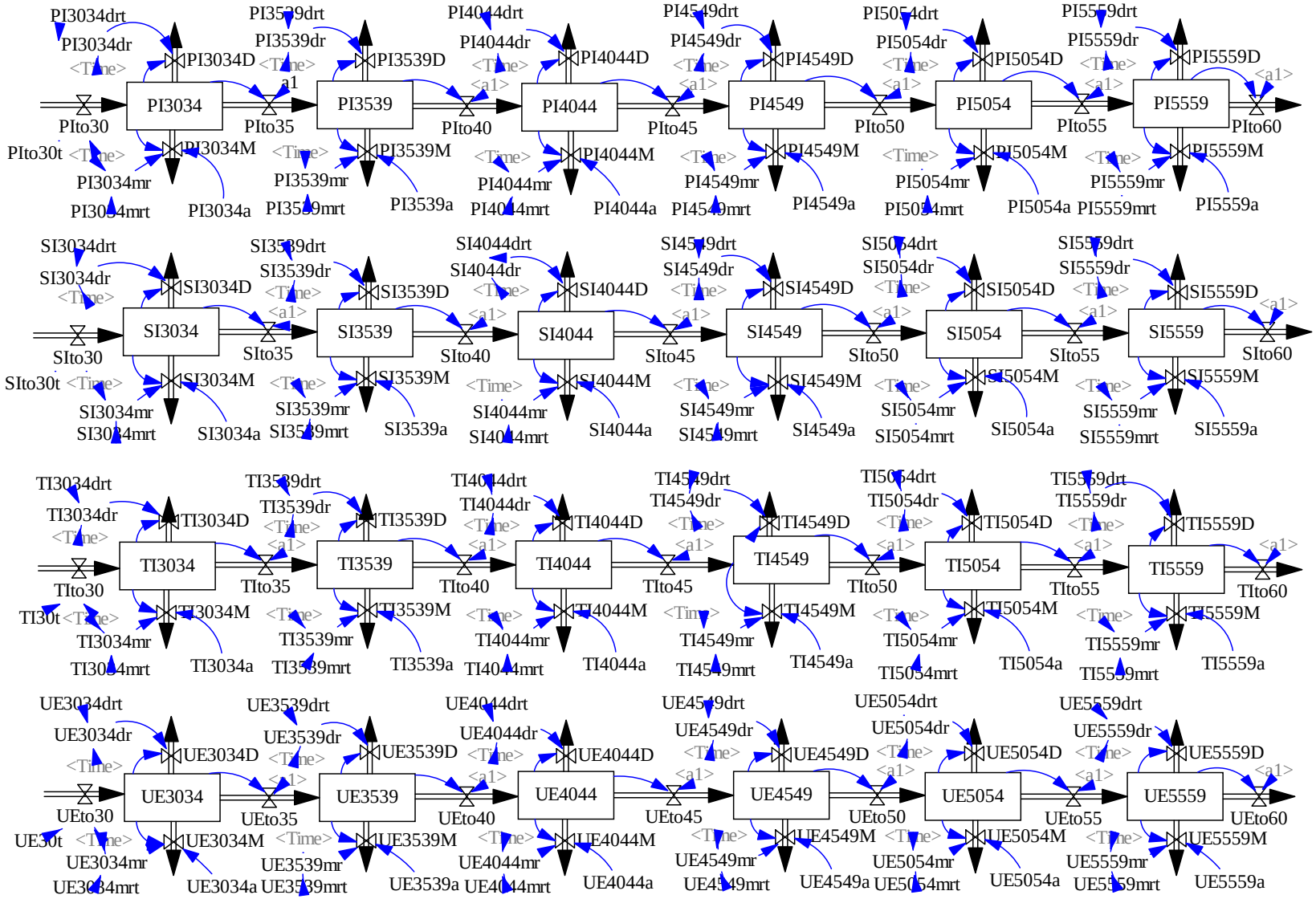

Figure 2. Overall structure of the model

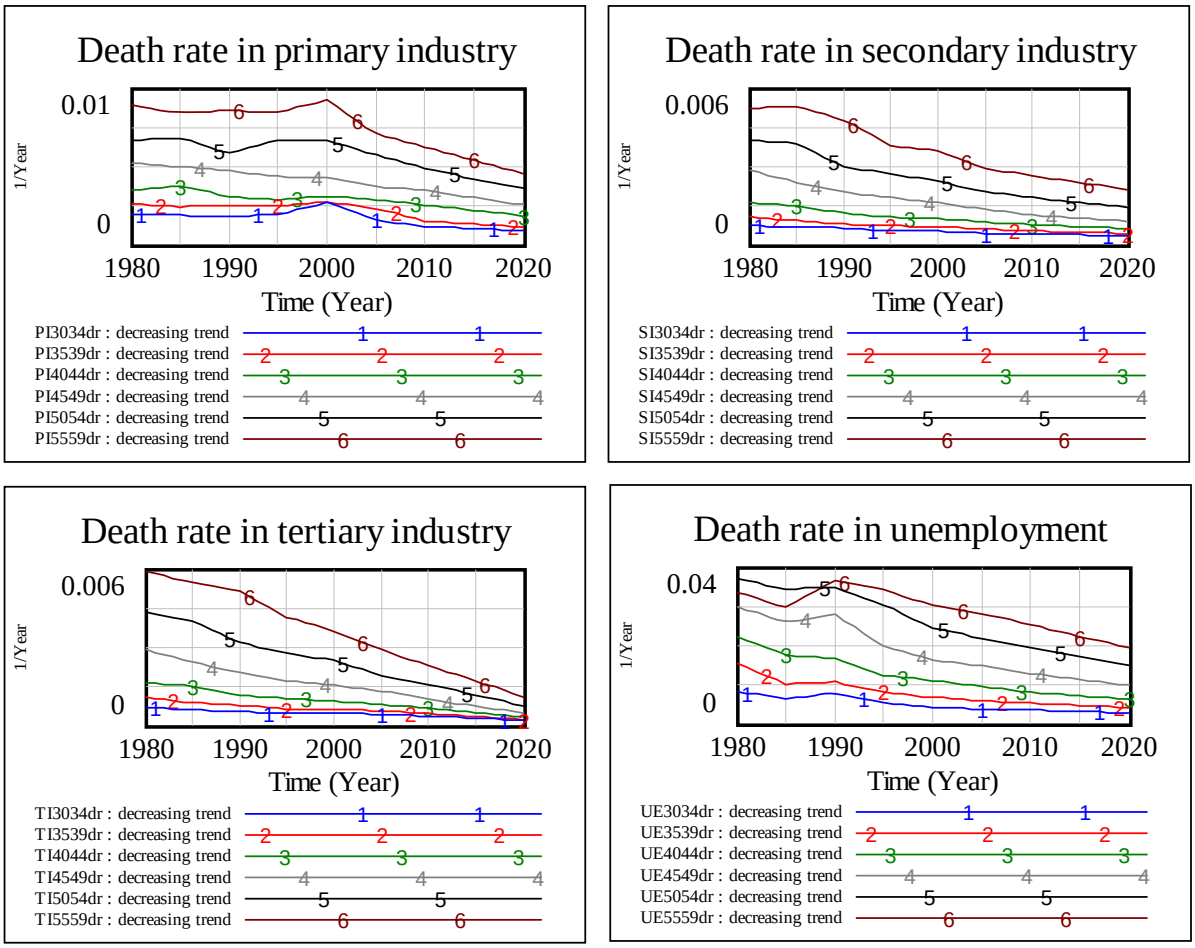

Figure 3. Death rates in the model by major groups of industry

SIMULATION OF THE MODEL

Population

Since around 1995, populations in the primary and secondary industries have been decreasing while that in tertiary industry has been stable and that in unemployment has been increasing (Figure 4). A total population will decrease by 2% from 24.1 million in 2010 to 23.6 million in 2020, and the percentage of unemployed men will increase by 22% from 9.2% in 2010 to 11.4% in 2020.

Peaks in the trends of populations by age groups showed increasing populations by the first and second baby booms (Figure 5).

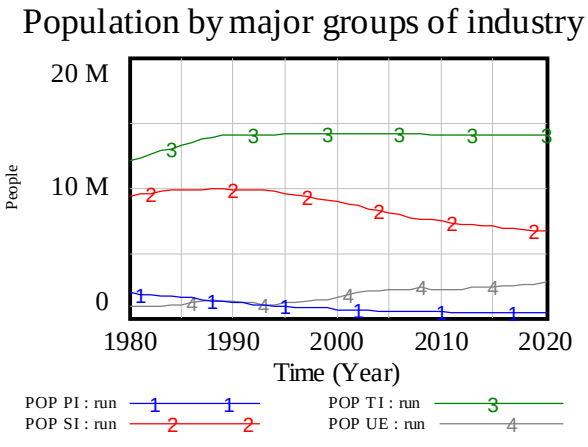

Figure 4. Population by major groups of industry

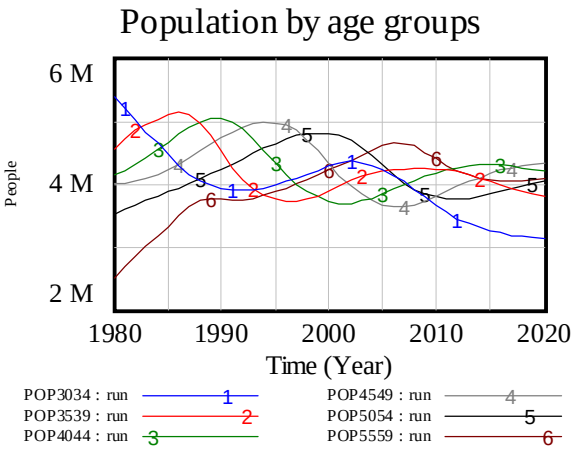

Figure 5. Population by age groups

Deaths

Since around 1985, numbers of deaths have been decreasing in the primary, secondary and tertiary industries while two peaks in late 1980s and mid 2000s were observed in deaths in unemployment (Figure 6). These peaks seem to have occurred mainly in age group from 55 to 59 years (Figure 7). The number of total deaths will decrease by 28% from 52,900 in 2010 to 37,900 in 2020, and the percentage of unemployed men will increase from 53% in 2010 to 62% in 2020.

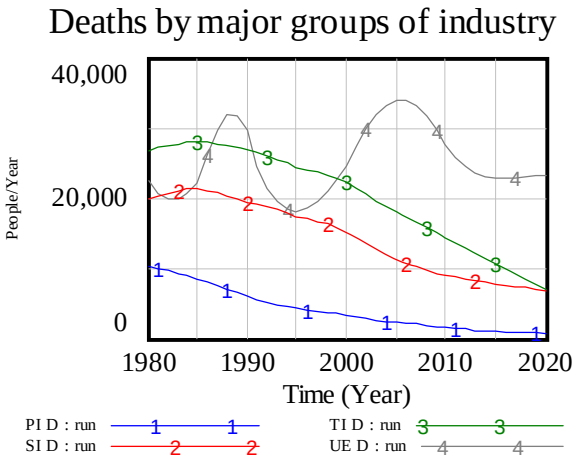

Figure 6. Deaths by major groups of industry

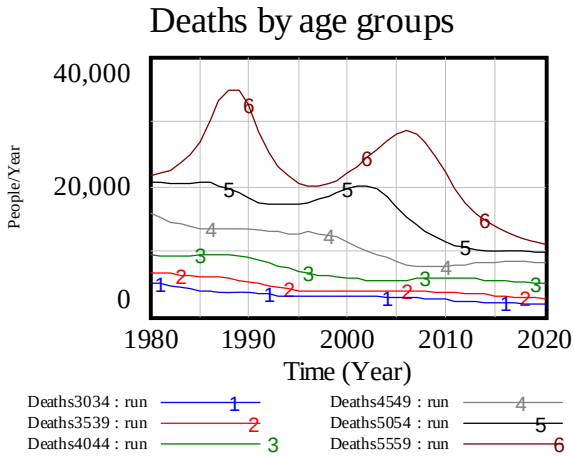

Figure 7. Deaths by age groups

CONCLUSION

A simulation model of deaths in Japanese working men aged 30 to 59 from 1980 to 2020 was developed by major groups of industry. The total population will not change between 2010 and 2020, but the percentage of unemployed men will increase by 22% from 9.2% in 2010 to 11.4% in 2020. Because of the declining death rates in all major groups of industry, the number of total deaths will decrease by 28% from 2010 to 2020. However, the percentage of deaths in unemployed men will increase from 53% to 62% from 2010 to 2020. Prevention of early deaths of unemployed men is an urgent public health issue in Japan.

ACKNOWLEDGEMENT

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