11/13/2003

Rapid Population Aging in Japan:

Simulated Results Based on the NUPRI

Economic-Demographic-Social Security Model

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I. Introduction

The story of Japan's miraculous postwar economic success has been told many times (Minami, 1986; Ogawa, Jones, and Williamson, 1993). No less striking, however, was the unprecedented rapidity with which Japan completed her demographic transition (Hodge and Ogawa, 1991; Ogawa, 2002). Among all the industrialized nations, Japan was the first to experience a fertility decline in the postwar period and it had the greatest decline in national fertility among these countries.

In contrast to the United States and European countries, the postwar baby boom in Japan was extremely short, lasting only three years, from 1947 to 1949 (Hodge and Ogawa, 1991; Ogawa and Retherford, 1993; Ogawa, 2003). After this short postwar baby boom, fertility declined sharply in Japan. During the 1947-1957 period, the total fertility rate (TFR) fell by more than half, from 4.54 to 2.04 children per woman. There were only minor fluctuations around the replacement level until the first oil crisis in 1973. Thereafter, the TFR started to fall again and reached 1.32 in 2002.

In addition, age-specific mortality rates declined during the last 50 years. Over the period 1947 to 1965, life expectancy at birth rose from 50.1 to 67.7 years for men and from 54.0 to 72.9 years for women. In 2002, life expectancy was 78.32 years for men and 85.23 years for women; both of these levels are currently the highest in the world.

As a result of these demographic changes, the age distribution of the Japanese population has been changing markedly, with a relative increase in the numbers of the elderly and a relative decrease in the numbers of the young. These age structural shifts have been generating a wide range of disruptions at both societal and familial levels in Japan over the past few decades.

In many respects, the aging of the Japanese population, the evolution of its social security system, and the transformation of the family are typical of what occurs in any population that experiences economic and social development and consequent demographic transition from high to low birth and death rates. The aging that occurs as a consequence of demographic transition is reflected in a rising old-age dependency ratio of the elderly to the working-age population that is a major contributor to the pressures to shift some of the burden of caring for the elderly from families to government, businesses, unions, and other institutions, as well as to the elderly themselves through personal savings for old age (Ogawa and Retherford, 1997).

In recent Japan, however, the forces driving the growth of the social security system have been so strong that the costs of the system have been escalating. These rising costs reflect not only increases in benefits at the individual level but also increases in the proportion of the population who receive benefits, as a consequence of population aging, extension of benefits to groups not previously covered, and maturation of the social security system. Another contributing factor is the growth of expensive medical technology and the increasing sophistication and cost of delivering health services.

The escalation of social security costs ultimately has resulted in government efforts to suppress these public costs. Nevertheless, these efforts tend to be rather modest, because the system serves the needs of the young as well as the old, and is generally popular. Moreover, the growing political influence of the elderly, derived from increases in their relative number and in their educational levels and political sophistication, tends to thwart efforts to alleviate benefits.

In this paper, we discuss, using the numerical results recently produced from a long-term simulation model, Japan's future trajectories of population, macroeconomic, and social security variables over the period 2000-2025. In the next section, the nature of the simulation model is described. In the subsequent two sections, projected demographic, macroeconomic, and social security paths are presented. In the final section, several policy options are briefly considered.

II. Outline of NUPRI's Long-term Simulation Model

As part of a United Nations' project, the Nihon University Population Research Institute (NUPRI, hereafter) formulated a macroeconomic-demographic-social security model for Japan in 1981. Since then, the NUPRI model has been periodically modified and updated. In this paper, we draw upon NUPRI's newest version that was completed in October 2002. As has been the case with the previous versions, the 2002 version of the NUPRI model consists of the following three submodels: the population submodel, the economic submodel, and the social security submodel. As displayed in Figure 1, these three submodels are interdependent; the population submodel is first determined by a set of economic and social security variables with a one-year lag, and the variables in both economic and social security submodels are simultaneously determined, using the computed demographic variables.

The NUPRI model is primarily a demand-driven type of a Keynesian nature. It should be noted, however, that the potential capacity of the supply side is also computed for each year of the simulation period, so that the calculated effective demand does not exceed the calculated supply capacity. It should also be added that most of the behavioral equations in the economic submodel have been estimated on the basis of time-series data over the period 1967-1997, and a number of initial value adjustments have been made for simulation purposes.

It is important to note that both fertility and mortality are endogenously determined within the macroeconomic-demographic-social security model. Although NUPRI's earlier models were based upon the new home economics approach (Butz and Ward, 1979; Ogawa and Mason, 1986) to capture the variation of Japanese fertility, the validity of this approach to contemporary Japan had become increasingly questionable due to a shift in the mechanism of fertility change. One of the recent fertility analyses based upon the techniques of formal demography shows that the impact of delayed timing of marriage on the TFR over the period 1995-2000 was most pronounced throughout the second half of the 20th century in Japan (Ogawa, 2003). In view of this finding, we have formulated a new TFR equation in which the change in the age-specific proportion single among women over time is a key explanatory variable, as depicted in Figure 2. It should be also noted that the proportion single is computed from the equation for earning differentials between men and women, and the latter is calculated from the change in sexual differentials in university enrollment. To sum up, in NUPRI's newest version, the TFR is expressed as a function of women's opportunity costs of marriage.

It should be borne in mind that the following two assumptions have been imposed in the process of projecting Japan's future TFR. First, taking into consideration the trend of diminishing gap of university enrollment between men and women over the last few decades, it has been assumed that the sexual gap in university enrollment will disappear over time. Another assumption used has been related to the upper ceiling value with respect to the proportion single among women. Because our preliminary analysis of marriage dynamics in postwar Japan has revealed that women aged 25-29 have been playing a key role of determining the nuptiality pattern over the past few decades, an attempt has been made to identify the upper ceiling value for the proportion single among women of this age group, and the adopted equation is a logistic regression with the upper boundary of 65 per cent.

As regards mortality change, the Lee-Carter method has been incorporated in the newest version of the NUPRI model. As described elsewhere (Lee and Carter, 1992), three parameters need to be estimated in the Lee-Carter method, using the singular value decomposition. The first two parameters (*a* and *b*) have been estimated on the basis of time-series data over the period 1950-2000. However, the remaining parameter (*k*) has been estimated as a function of the per capita medical expenditure measured in terms of

1990 constant prices, although the conventional Lee-Carter method assumes a function of the time trend. Owing to the limited availability of data pertaining to the per capita medical expenditure, the sample period employed for the estimation of this parameter was 30 years, namely, from 1970 to 2000.

It is also worth remarking that we have computed, using the Lee-Carter method, the 90 per cent confidence interval of the projected mortality trajectory to quantitatively show its possible range of variations. Figure 3 presents how well the 90 per cent confidence interval of the Lee-Carter method keeps a track of actual mortality changes in recent Japan. In this exercise, the parameters have been estimated over the period 1950-1995, and these estimated parameters have been utilized to forecast the mortality change during the period 1995-2000. As can be clearly seen by inspecting these forecast results, one may safely conclude that the traceability of the Lee-Carter method in contemporary Japan is extremely satisfactory.

In so far as the social security submodel is concerned, strenuous efforts have been made with a view to modeling the government's recent policy changes with regard to both public pension schemes and medical care plans. In the case of the public pension schemes, a number of revisions were made in 1999, and these modifications have been incorporated in NUPRI's newest version of the long-term model. In addition, the government medical insurance schemes, which are another vital component of the social security system, have been modeled in great detail. To measure the effect of future changes in both the size and the structure of the Japanese population upon the costs of these government medical schemes, the following methodology has been adopted. For each of the three major medical insurance schemes, the age-specific total medical cost is computed as the product of the four matrices shown as below:

$$\begin{pmatrix}\text{Population}\\\text{by age and}\\\text{sex}\end{pmatrix} \times \begin{pmatrix}\text{Age-sex-specific}\\\text{probability of being}\\\text{enrolled in the scheme}\end{pmatrix} \times \begin{pmatrix}\text{Age-specific medical care}\\\text{cost per case}\end{pmatrix}$$

$$\times \begin{pmatrix}\text{Age-specific incidence of}\\\text{receiving medical}\\\text{treatment}\end{pmatrix} = \begin{pmatrix}\text{Age-specific total}\\\text{medical care cost}\end{pmatrix}$$

The product of the first two matrices corresponds to the age-sex-specific number of those enrolled in the particular health insurance scheme. By multiplying this product by the third matrix, one can obtain the age-specific total number of medical cases (or patients) treated under the specific health insurance scheme. It should be noted, however, that due to data limitations, the multiplication has been done only on an age-specific basis rather than on an age-sex-specific basis. Then, the age-specific total medical care cost can be calculated by multiplying the age-specific total number of medical cases by the age-specific medical care cost per case. The total medical care expenditure for each health scheme can be obtained by adding the age-specific total medical care cost for all age groups. The parameters for the first matrix are derived from the population submodel, while those for the other three matrices have been calculated from sampled data.

There are a few advantages in this computational method. One of the advantages is that, because the four matrices on the left-hand side of the formula are all age-specific, the population growth effect as well as the age structure effect on medical care expenditure is directly captured. Another advantage of this method is that it enables us to accurately identify some of the sources of a rise in medical expenditure. Note that except for the matrix for the population by age and sex, the parameters for the remaining three matrices on the left-hand side of the above formula have been derived from data for 1997. By multiplying these three matrices by the population actually observed in earlier years, one can project backward to ascertain the hypothetical age-specific total medical care cost for each of these years. Because a close examination of past data reveals that the parameters for the second and third matrices have been relatively stable, the difference between the hypothetical age-specific total medical care cost and the observed age-specific total medical care cost is attributable to (i) the price effect and (ii) the residual effect. Information on the time-series changes in the price for medical care services is available, so that the magnitude of the residual effect for each age group can be easily estimated. Roughly speaking, the computed residuals can be regarded as the cost-push effect due to the changing pattern of illness and medical technological advancement. In the NUPRI model, the age-specific residual effect for each health insurance scheme has been incorporated as a function of real GDP per capita. Each of these equations has been estimated, employing annual data from the mid-1970s to 2000. To project these effects on total medical care expenditure over the simulation period, the levels of both real GDP per capita and nominal GDP are provided from the economic submodel.

III. Japan's Demographic Scenario during 2000-2025

Based upon a population projection produced from the most recent version of the NUPRI model, we analyze Japan's future pattern of population aging over the period 2000-2025. Table 1 presents projected results. Japan's total population, which was 126.5 million in 2000, is projected to increase to 127.5 million by 2005. After reaching this peak, the nation's population is expected to decrease continuously to a level of 120.1 million by 2025.

This projected result for the total population is derived from changes in the two vital rates of fertility and mortality. With regard to the fertility rate, the TFR is projected to decline from 1.36 in 2000 to 1.24 in 2017. After 2017, however, it is expected to remain virtually unchanged during the rest of the projection period.

The life expectancy at birth for males is anticipated to rise from 77.64 years in 2000 to 83.85 years in 2025. In the case of females, the corresponding expected change is an increase from 84.62 years in 2000 to 89.44 years in 2025. Figure 4 shows these projected results, coupled with the 90 per cent confidence interval for each sex. These mortality future trajectories suggest that the life cycle pattern of the Japanese population is likely to shift to a pronounced extent over the next quarter century. Furthermore, it should be stressed that the magnitude of uncertainties involved in these projected mortality scenarios is considerable, as indicated by the 90 per cent range of forecasting errors. For males, the computed range is from 81.76 to 85.55 years, and for females, from 88.04 to 91.21 years. These uncertainties involved in the simulated results for Japan’s future mortality changes point to the need for each individual to make an appropriate contingency plan for the final few years of his/her life.

Though not shown in Table 1, the total number of those aged 65 and over grows monotonically from 22.0 million in 2000 to 37.3 million in 2025. Moreover, due to sexual mortality differentials at higher ages, the predominance of women among the aged population is expected to become increasingly pronounced over time. Figure 5 depicts the projected “surplus” of women at ages 65 and over, and attention should be drawn to the computed result that the number of very old women aged 85 and over will increase at an astonishing pace over the next 25 years. This fast feminization of the very old population suggests that in a virtually universal marriage society such as Japan, the number of widows will grow rapidly in the next few decades. Because of declining family support by adult children (Ogawa and Retherford, 1997; Ogawa, 2002), the increase in elderly widows is very likely to lead to a considerable rise in the demand for institutional care in the years ahead.

Several important points emerge with regard to the age compositional changes displayed in Table 1. First of all, in 2000, the proportion of the population at ages 0-14 is 14.6 per cent, and the proportion of those aged 65 and over is 17.4 per cent. Throughout the projected period, the former is on the downward trend, but the latter increases continuously. In 2013, the ratio of the elderly aged 65 and over to the young at ages 0-14 is projected to exceed a value of 2, as indicated by the index of aging.

Second, though not shown in Table 1, the Japanese population is likely to become the oldest human population in 2003, surpassing the Italian population. As indicated in Table 2, Japan's population will be by far the world's oldest by 2025. More importantly, the Japanese population will reach the world's highest level of aging at an unprecedented rate, as displayed in Table 3. Japan's aged population reached the 10 per cent level in 1984 and was the latest among all the industrialized nations listed in Table 3. Despite this delayed onset, Japan is the first country in which the aged comprise more than 20 per cent of the total population among all the countries appearing in this table. The length of time required to increase from 10 to 20 per cent of the Japanese population is only 21 years. Compared with such European countries as Sweden and Norway, Japan will age at a tempo approximately three times as fast.

Third, the aging of the aged population itself deserves special attention. As shown in Table 1, the proportion of those aged 75 and over in the population aged 65 and over grows rapidly over the entire projected period. It is projected to rise from 40.9 per cent in 2000 to 59.6 per cent in 2025. A close examination of this projected result and country-specific data produced from the recent population projection prepared by the United Nations (2001) reveals that Japan's level for 2025 is likely to be by far the highest in the world, followed by Sweden (51.9 per cent). Obviously, this marked age compositional shift of the Japanese population will generate a substantial effect on the pattern and level of demand for medical care services, as will be discussed in the next section.

Fourth, though omitted from Table 1, it is worth noting at this point of our discussion that the number of those aged 100 and over is projected to increase at an annual rate of 11.1 per cent during 2000-2025, which implies that this age group is the fastest growing segment of the population. In 1963, the number of centenarians was only 153, but it is expected to grow to more than 168,000 in 2025, as indicated in Figure 6.

Fifth, it should be noted that although the total dependency ratio was relatively low until the end of the 20^{th} century, the index is expected to increase continuously, thus reaching its peak value of 70.1 in 2025, as presented in Table 1. Japan’s value for

2025 will be the highest among all the industrialized nations at that time. Though not shown in Table 1, it is interesting to note that the peak of total dependency over the projected period is highly comparable to Japan's highest level (71.6) recorded in 1920. It has been observed in a few existing studies (Wander, 1978) that the average per capita total expenditure (private and public) is roughly equal between young and old dependents. If this observation holds true for Japan, one may say that because Japan had already experienced greater total dependency in the prewar period, the rising total dependency burden to be placed upon the productive population in 21st-century Japan will be within a manageable range. It should be stressed, however, that over the next three decades, Japan's tempo of the increase in total dependency is the fastest among all the industrialized nations, thus suggesting that Japan, compared with other developed nations, is likely to face more formidable adjustment problems in reallocating resources among various age groups.

Sixth, the familial support ratio, which relates the female population at ages 40-59 to the total population aged 65-84, is expected to decline substantially over the next 25 years, as displayed in Table 1. The value of this index was 1.30 in 1990, and is projected to be 0.65 in 2010, thus indicating that it will decline by 50 per cent in 20 years' time. These results indicate that the demographic potential of familial support by adult children for the elderly diminishes rapidly, starting from 2007 when a large age cohort glut of baby boomers disappears from the age group 40-59. The declining trend of the familial support ratio points to the high likelihood that the traditional extended family system will be continuously weakened over time. Although the government started in 2000 the Long-term Care Insurance Scheme (LTCI) to alleviate the family's burden in taking care of older parents at home, the number of households without any caregivers is expected to rise so that the effectiveness of this new scheme is likely to be increasingly limited over time.

In Table 4, these projected results are compared with those of the United Nations population projection undertaken in 2000. In 2005, Japan's familial support ratio will be the lowest in the entire world, followed by Greece and Italy. More importantly, these projected results are highly reliable because the numbers going into the denominator and the numerator have already been born.

Seventh, the median age of the population is forecast to rise dramatically in the years to come. In the case of both sexes combined, it increases from 41.5 to 51.1 years old during 2000-2025. This implies that more than half of the Japanese population are above age 50, thus suggesting that the incidence of late marriages and remarriages among the elderly might grow substantially over time. As for men, the corresponding shift is from 39.8 to 50.0 years old, while it is from 43.1 to 53.3 years old for women, as presented in Figure 7.

IV. A Macroeconomic Scenario: Limits to the Support System for the Aged

The NUPRI model has also yielded a projection of a host of macroeconomic and social security-related variables over the period 2000-2025. Among these variables, we have selected, as shown in Table 5, several key variables with a view to discussing some of the major impacts of population aging upon the socioeconomic system in Japan.

Although real GDP is projected to increase by 1.34 times over the 25-year period, its annual growth rate slows down over time from 1.9 per cent during 2000-2010 to 0.9 per cent in the 2010s, and to 0.2 per cent from 2020 to 2025. In addition, nominal GDP is projected to grow at a declining pace over time. The average annual growth of nominal GDP is 2.9 per cent over the period 2000-2010, 1.6 per cent in the 2010s, and 0.5 per cent during the period 2020-2025. These projected results indicate that the annual rate of inflation declines slowly over time, thus suggesting that it will be increasingly difficult for both business and government sectors to reduce their accumulated debts.

The male contribution rate for the leading pension scheme (Employees' Pension Scheme, EPS) is projected to grow from 17.35 per cent (of an employee's monthly salary) in 2000 to 27.91 per cent in 2015, and 30.97 per cent in 2025. These projected contribution rates are considerably higher than those calculated by the government on the occasion of the 1999 major pension revision, as displayed in Figure 8. The government's calculations revised in 1999 show that the corresponding rates will rise from 17.2 per cent in 2002 to 27.7 per cent in 2025. These substantial differences in the male contribution rates between NUPRI's estimate and the government's calculation are attributable primarily to the marked difference in the pattern of mortality improvements between NURPI's population projection and the government's population projection.

The total medical expenditure measured in nominal terms is expected to rise almost 1.9 times over the 25-year period. This increase in medical care costs is attributable to both the aging of the population and further medical technological progress. The share of Japan's national income required for medical expenditure rises gradually from 7.4 per cent in 2000 to 8.7 per cent in 2025. At this juncture, it is interesting to compare these projected figures with the levels being experienced in some of the other industrialized nations. The share of national income allocated to medical expenditure, which is adjusted for intercountry differences in coverage, was 11.6 per cent for France in 1998, 11.7 per cent for Germany in 1997, and 11.8 per cent for the United States in 1998 (Health and Welfare Statistics Association, 2001). When compared with these statistics, the projected results for Japan over the next 25 years indicate that it is unlikely to reach such levels.

To cope with these rising social security costs, the contributions to the social security system are likely to be raised substantially. How much will Japanese taxpayers be required to contribute to the social security system over the next 25 years? In 1996, the government of Japan set a ceiling for the tax burden arising from financing the social security programs. According to the government plan, the national financial burden defined as [(social security contributions + taxes) / national income] should be kept below 45 per cent in the years to come. As presented in Table 5, although it appears to meet this target until 2020, it is projected to exceed this upper boundary during the period 2020-2025, thus reaching 45.7 per cent in 2025.

Apart from the demand-side factors, the supply side is also expected to change considerably over time. It should be noted that the computed effective demand is considerably below the potential supply capacity up to 2010, and the former exceeds the latter over the remaining projected period. This implies that the supply side factors play an important role of determining Japan’s GDP, particularly in the latter half of the projection period.

One of the principal factors on the supply side is the supply of labor. The total supply of labor reached its peak value of 67.9 million in 1998, and is projected to continue decreasing throughout the projected period. It is the first time in modern Japanese history that the supply of labor is on a long-term declining trend. This negative growth of the labor supply is induced by such factors as (i) a marked decrease in the number of new entrants due to sustained low fertility and to a further rise in educational enrollment at the tertiary level, and (ii) a continuous fall in the labor force participation rate of the elderly through an increase in the per capita pension benefit as well as reduced employment opportunities in the primary industries where many elderly workers are engaged. Although the labor force participation rate for middle-aged women is projected to rise considerably over the next 25 years, this positive effect is not large enough to offset the numerous negative effects on labor force growth.

The other important factor on the supply side is savings. One of the primary sources of the decline of real GDP growth performance in the second half of the projection period lies in a substantial fall in the saving rate. As presented in Table 5, the gross national saving rate is projected to decrease substantially over time, declining to 6.2 per cent by 2025. The expected rise in social security contributions as well as in household consumption resulting from population aging is mainly responsible for the fall in the saving rate; increased social security contributions lead to a rise in the wage bill, which will, in turn, reduce corporate savings; and the growth of retirees relative to workers depresses household savings, as is theoretically consistent with the framework of life cycle savings (Mason, Ogawa, and Fukui, 2001; Mason and Ogawa, 2001). It should also be noted that Horioka (1988) examined 30 different factors on the basis of data gathered from various OECD countries including Japan, and identified the following three significant factors accounting for Japan's high household saving rate: (i) the low proportion of the aged population, (ii) the bonus system, and (iii) the rapid rate of economic growth. The NUPRI model shows that both the first and third factors are likely to adversely affect Japan's household savings as its population aging process advances.

It is worth noting, however, that the above result for the saving rate may differ considerably if the following two mechanisms are incorporated in the model. First, Ando (1985) has suggested the possibility that further improvements of life expectancy may motivate Japanese workers to save more. Second, although the low interest rate policy has been implemented by the monetary authorities in postwar Japan, it is likely to rise in the future as Japan's financial liquidity diminishes in the process of population aging. Then, the higher interest rates in the domestic financial market will not only prevent a flight of capital abroad but also induce a return or inflow of capital from outside. Despite the declining savings rate, therefore, this shift of capital may lead to an increased capital-labor ratio, thus facilitating favorable growth performance. These two considerations, however, are not incorporated in the NUPRI model.

The foregoing discussions indicate that Japan’s future economic prospect is extremely gloomy, namely, a further slow-down of economic growth and a rapid rise in the costs of the social security system. In view of these future trends, further downward adjustments need to be made with respect to the social security benefits paid out. In the process of downward adjustments, however, the intergenerational inequity issue is likely to arise in the public arena. To mitigate such intergenerational conflicts, long-term planning is essential, and revisions should be made well before the process of population aging accelerates.

The choice between these alternative scenarios will clearly affect the extent to which families provide care to their elderly parents at home. As the aging process advances, elderly patients who need intensive nursing are expected to increase at an alarming rate. In the NUPRI model, the number of those aged 65 and over who are bedridden or suffer from senile dementia has been estimated for the next 25 years, by assuming that the age-sex-specific pattern of the incidence of being each type of patient remains unchanged throughout the projected period. The number of bedridden patients, either at home or at medical institutions, will grow by 2.2 times, i.e., from 1.25 million in 2000 to 2.70 million in 2025. The total number of senile dementia cases will increase by 2.4 times from 1.64 to 3.99 million during the corresponding period.

This difference in the magnitude of growth between the two types of elderly patients is explained by the following two factors. First, at higher ages such as 75 years and over, the incidence of having senile dementia is much higher than that of being bedridden. Second, as discussed in the earlier section, the aging of the aged will become increasingly pronounced over the next few decades.

A substantial proportion of these elderly patients has been and will be looked after at home by their adult children, particularly non-working middle-aged women. With this family support pattern borne in mind, we have projected the ratio of elderly patients at home to women at various ages outside the labor force. To facilitate this computation, it has been assumed that the current age-sex distribution of female care-givers at home will remain constant in the future. Moreover, the number of non-working women at varying ages has been calculated by multiplying the age-specific female population by (1 - FLFPR), where FLFPR stands for the female labor force participation rate for the corresponding age group; both of these population and economic variables have been derived from the economic submodel of the NUPRI model. The ratios have been computed for the following six age groups: 20-29, 30-39, 40-49, 50-59, 60-69, and 70 and over.

The estimated results are shown in Figure 9. As can be seen by inspecting the graphical exposition, the ratios of the aged population at home suffering from senile dementia or being bedridden to women outside the labor force grow over time for all age groups. It can also be noted that although the differences in the ratios among these age groups are very small in the early years, they expand markedly over time. Furthermore, non-working women in their 40s consistently show the highest ratio throughout the projection period. Approximately one out of every seven women aged 40-49 assumes responsibility for taking care of one infirm elderly person at home in 2000, but almost 50 per cent of the non-working women of this age group is likely to provide in-home care to elderly patients in 2025. These differences over time in the pattern of increase in the computed ratios among the six age groups are attributable to changes in their labor force participation rates as well as in their cohort size.

The above computational results point to a dramatic rise in the burden placed upon middle-aged Japanese women providing in-home nursing for the infirm elderly. These results are likely to change drastically, depending upon the future availability of both (i) public support services through social security programs such as the Long-term Care Insurance Scheme (LTCI), and (ii) long-term care institutions. The degree to which care for elderly patients is internalized through Japan's traditional familial support network is also contingent upon the magnitude of the future demand for female labor, and upon the commitment of future cohorts of women to care for their elderly kin with serious infirmity or illness at home. In view of the financial constraints on the part of the government, the recent trend for female paid employment (Ogawa and Clark, 1995; Ogawa and Ermisch, 1996; Ermisch and Ogawa, 1994) and the rapid filial normative shift (Ogawa and Retherford, 1993; Retherford, Ogawa, and Sakamoto, 1999), the financial and manpower outlook for providing care for Japanese infirm elderly is rather negative.

In the newest version of the NUPRI model, we have also estimated the proportion of the elderly who are healthy, and the proportion of those not healthy. Among those unhealthy, and the proportion of the elderly who need assistance from other persons in performing certain ADLs (activities of daily living) and IADLs (instrumental activities of daily living) has been computed. The data source of this numerical experiment is the Nihon University Japan Longitudinal Study of Ageing (NUJLSOA), conducted in 1999. The total number of the respondents was 4,997 persons aged 65 and over, with the response rate of approximately 75 per cent.

This nation-wide survey collected information on the elderly’s physical ability called “Nagi measures.” These measures include the following physical activities: (1) walk 200 to 300 meters (2 to 3 blocks), (2) climb 10 steps of a stairs without resting, (3) stand straight for 2 hours, (4) continue to sit for 2 hours straight, (5) stoop or bend your knees, (6) raise your hands above your head, (7) extend arms out in front of you as if to shake hands, (8) grasp with your fingers or move your fingers easily, and (9) life an object weighing approximately 10 kg. If an elderly person cannot perform any one of these physical activities without someone else’s assistance, he/she is considered to have difficulty in working.

In addition, the following ADL and IADL information that has been collected in the 1999 survey is used to measure the degree of assistance: (1) taking a bath/shower, (2) dressing, (3) eating, (4) standing up from a bed or chair; sitting down on a chair, (5) going to the bathroom and taking care of necessary functions (using the toilet), (6) leaving the home to purchase necessary items or medication, and (7) taking the bus or the train to leave home. For each of these ADLs or IADLs, the respondent was asked whether or not he/she could perform it without difficulties. If the respondent cannot perform any one of these activities, he/she is considered to be “unhealthy.” Moreover, in the case of unhealthy elderly persons, we have further classified into the following two categories: (i) “unhealthy but assistance unnecessary,” and (ii) “unhealthy and assistance necessary.”

Based upon these pieces of information, we have estimated a change in the health status and the level of assistance required for daily activities among the elderly during the period 2000-2025. The computed results are shown in Table 6. The number of the elderly aged 65 and over who find it difficult to work is projected to increase by 1.46 times over the next 25 years. In absolute terms, the number of elderly persons having difficulties in taking the bus or train is expected to show the largest increase over the 25-year period, followed by that for those having difficulties in going shopping. In relative terms, as displayed in Table 6, the number of those who need assistance for eating is anticipated to grow at the fastest pace among the seven activities listed in the table, followed by toileting as the second fastest growing activity. These results imply that assistance required by the elderly will shift over time from activities outside home to activities related to human basic needs such as eating and toileting. Thus, the nature of assistance to be provided by home-helpers to the elderly under the Long-term Care Insurance Scheme is prone to change over time.

V. Japan’s Policy Options

In this paper, we have discussed Japan’s unprecedented population aging processes and their adverse impacts on the socioeconomic system. Because the reduction of fertility is a principal demographic factor accelerating population aging in Japan, the government has been recently making strenuous efforts to implement a variety of policies and programs to remove or mitigate difficulties involved in child-rearing. However, to evaluate the impact of these government programs on actual fertility behavior is still premature and remains to be seen (Ogawa, 2003).

Apart from the promotion of various policy measures to raise fertility, what else can Japanese society do to retain its dynamism in the 21st century? Although both abundance of high-quality human resources and the high saving rate have been two principal driving forces of Japan’s remarkable postwar growth performance, it is very likely, as described (above) by the model simulation scenario, that both forces will drastically change as the aging process advances over the next few decades. In addition, the borrowing of technologies from Western developed countries has also played a crucial role in placing the Japanese postwar economy on the high growth path, but Japan has now entered the stage where it has to develop its own new technology, by allocating greater resources to research and development activities. Undoubtedly, these financial, manpower and technological constraints will pose formidable challenges to Japanese bureaucracy, businesses and households. What should be done to cope with these challenges?

Better Utilization of Aged Workers

The model simulation results show that the supply factors, particularly the labor supply, constitute a major bottleneck to sustaining economic growth after 2010. One of the ways to overcome this supply-constrained growth scenario is to facilitate a better utilization of elderly workers. Despite its declining trend, the labor force participation rate of Japanese older people still remains at a much higher level than the participation rates of older people in other industrialized nations. The aging of the Japanese population has reduced the number of young workers entering the labor force each year and increased the number of older workers attaining their firms' traditional retirement age of 60 or so. These changes are requiring significant alterations in the compensation and personnel policies of many firms. The aging of the Japanese population is also placing considerable stress on the government as it attempts to finance retirement and health care system for elderly people (Ogawa, 1993; Clark and Ogawa, 1996).

In response to the increased social security costs, the government raised the age of eligibility for social security benefits to age 65 (effective in the year 2013). The government also is attempting to encourage firms to raise the age of mandatory retirement through the provision of subsidies and other assistance. Firms have been reluctant to increase their retirement age across the board because of the higher costs associated with older workers. This dichotomy of public interest in higher retirement ages and private employers' interests in not increasing labor costs is clearly seen in Japan (Clark and Ogawa, 1996).

One of the principal obstacles to raising the mandatory retirement age is related to the seniority wage system practice.

In response to the aging of the labor force, many businesses, particularly large firms, have been gradually modifying the seniority-based wage system by introducing ability-oriented elements (Clark and Ogawa, 1992b). A key factor is how quickly Japanese businesses can change their management strategy formed during the labor-surplus period, and replace the seniority-based wage structure with the ability-oriented remuneration system. Also, evidence gathered to date indicates that the government's various subsidy programs for facilitating the extension of the retirement age are not enough. To achieve the government's specific goals, it may be necessary to impose heavy penalties for noncompliance rather than to rely on persuasion to influence employers.

Raising Women's Labor Force Participation

Another labor-related policy option is to raise female participation in the labor force. The age-specific labor force participation rates of Japanese women still show an M-shaped pattern, although participation among middle-aged women has been rising in recent years primarily due to their advanced education, to the shortening of the reproductive span, and to a more modern life-style (Shimada and Higuchi, 1985; Ogawa and Clark, 1995; Ogawa and Ermisch, 1994, 1996). It should be stressed that slightly more than half of married women working as paid employees are part-time workers, and that this proportion has been growing at a rate faster than that of full-time workers since the late 1970s (Ogawa and Retherford, 1993). This increased importance of part-time employment is related to the income tax rules i.e. a female spouse who earns more than one million yen a year must not only pay income tax but also lose her dependent with regard to her spouse's income and social security arrangement. The removal of these tax rules is expected to lead to a further rise in the participation of middle-aged women in full-time paid employment. In addition, as discussed earlier, the recent series of governmental efforts - to formulate and implement new policies and programs to facilitate fertility increases and promote women's work attachment - need to be further strengthened, so as top enable a more flexible labor market for women in Japan.

Labor-saving Technology and More Efficient Use of Young Workers

Japan's future shortage of young workers can be partially remedied by the development of labor-saving technology such as robots and automated production methods. At the same time, older workers should be encouraged to familiarize themselves with the use of microelectronics and related modern technology. To facilitate this process, part of the technical development efforts should be directed toward simplifying the operation of production equipment so that elderly workers can easily use it. Also desirable is a better utilization of young workers. To promote technological innovations, a considerable proportion of these young workers with modern scientific knowledge should be effectively allocated to advanced technology-developing sectors, preferably through government incentive and disincentive schemes.

International Labor Migration

International labor migration, another policy option, is a recent phenomenon in Japan. At present, although the Japanese government allows businesses to export wealthy retired persons to various resort areas in several countries such as Australia and Canada (Martin, 1989), it prohibits business firms from importing labor except for those with highly-specialized skills such as foreign language teachers and professional athletes (Ogawa, Jones and Williamson, 1993). The proportion of foreign nationals in the Japanese labor force is the lowest percentage among the industrialized nations (Abella, 1989).

In June 1990, the Immigration Law was amended to tighten a further inflow of illegal foreign workers. Unlike the case of Singapore where non-national employees are penalized for working illegally, employers are penalized for permitting foreign employees to work for them. The maximum penalty faced by such employers, according to the revised provision, includes imprisonment up to three years or a fine of up to 2 million yen. One additional important feature of the 1990 amendments is that a quota-imposed training program was instituted. The total number of foreign trainees (who are actually unskilled workers) should not be more than five percent of the total number of employees working for each firm. Accordingly, firms with less than 20 workers are not allowed to have any foreign trainees.

Caution should be exercised, however, with regard to Asia’s potential for supplying labor to Japan. In the first quarter of the 21st century when Japan’s population aging process accelerates, some of the developing Asian countries where the tempo of fertility reduction is fast may not have enough labor surplus to export to Japan.

Direct Foreign Investment

The model simulation results show that the supply factors, particularly the labor supply, will constitute a major bottleneck to sustaining economic growth beginning from the mid-1990s. One of the ways to overcome this supply-constrained growth scenario is to shift a considerable amount of production to areas outside Japan by exporting capital to the sources of cheap labor. This policy option is, however, threatened by political instability in receiving countries, and the loss of Japanese comparative advantages as a result of Japan's transfer of technology and management skills to business leaders in the receiving countries.

Social Security Reform

A few policy areas seek to curb the escalating costs of the social security system. One policy area relates to a further reduction of social security benefit levels and coverage. In the realm of medical care services, cost-containment policies such as those involving the *diagnosis-related group* (DRG) approach, the acceptance of the euthanasia concept, and the recognition of brain deaths are conceivable options for Japan. To reduce the manpower and financial requirements for bedridden patients and those suffering from senile dementia, modern technology such as *telemedicine* (a computerized diagnostic system linking homes and hospitals) is now being used experimentally in selected areas. If these policies are to be implemented, however, they may lead to the loss of the human touch in medical care services as well as a shortening of the Japanese life expectancy, which will, in turn, affect Japan's future aging processes.

Increasing Wealth

In the recent past, Lee, Mason and Miller (Mason, 2001) examined the impact of child-bearing, life expectancy, and age structure on the demand for wealth. Their simulation exercises have shown that the rapid transitions that have typified several East Asian countries produce large swings in aggregate saving rates and that the saving rate at the end of the transition will be higher than at the beginning. They have also suggested that in the process of the transition, the demand for wealth, as measured by the ratio of wealth/output, would converge to a higher level than we find today. Mason and Ogawa (2001) have tested the applicability of these theoretical considerations with respect to data from Japan's National Family Income and Expenditure Surveys for 1974 and 1994, and their results seem to be supportive of such possibilities.

These findings suggest that although Japan's saving rate will fall over the next few decades, the demand for wealth is likely to rise for a considerable period of time in the next century. If this scenario is valid, Japan's future course varies considerably, depending on how the increasing wealth will be used.

Redefining the Age Category of Elderly Persons

In a country like Japan which is basically an age-graded society, the possibility of redefining the age of elderly persons can be explored. Up to this point, our discussions have been based on the definition that the age category of the elderly population is 65 years old and over. This fixed definition of age of the elderly leads to many serious adjustment problems in the labor market and in the operation of the social security system. To solve these problems, therefore, one can propose that a new concept of the age category of elderly persons be introduced. In the case of Japan, if the definition of the aged is gradually shifted from 65 years old and over in 2000 to 75.75 years old and over in 2025, as depicted in Figure 10, the proportion of the elderly will remain at 17 percent for the next 25 years. Undoubtedly, this change in the definition of the aged will call for massive social engineering under strong government leadership in cooperation with the business sector.

The desirability and feasibility of each of these policy options need to be carefully assessed before they are implemented. It should be borne in mind that some of these policies require a considerable amount of time before they show their effects. However, because the problems arising from the unprecedented aging of the Japanese population are quite imminent, there is no time to waste.

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Table 1. Projected demographic changes for Japan, 2000-2025

Year	Total population (million)	0-14 years old (per cent)	15-64 years old (per cent)	65+ years old (per cent)	75+ / 65+ (per cent)	Total dependency ratio	Index of aging	Familial support ratio*
2000	126.9	14.6	68.1	17.4	40.9	46.9	119.1	0.91
2005	127.4	13.8	66.2	20.0	45.1	51.0	145.3	0.77
2010	127.0	13.0	64.0	23.0	48.3	56.3	176.2	0.65
2015	125.6	12.1	61.0	26.9	48.6	63.8	223.1	0.59
2020	123.2	11.0	59.5	29.5	52.1	68.0	267.7	0.57
2025	120.1	10.2	58.8	31.0	59.6	70.1	305.2	0.56

*Women aged 40-59/population aged 65-84.

Table 2. International comparison of the projected proportion of those aged 65 and over for selected industrialized nations in 2025

Country	Percentage
Japan	31.0
Italy	25.7
Greece	24.3
Sweden	25.4
Finland	25.2
Spain	23.6
Germany	24.6
Netherlands	21.9
Switzerland	27.1
Belgium	23.7
France	22.2
Denmark	22.5
Austria	24.3
Norway	21.8
United Kingdom	21.9
Canada	20.7
U.S.A	18.5

Sources: United Nations, *World Population Prospects: The 2000 Revision*, New York, 2001.
Data for Japan are based on the NUPRI population projection.

Table 3. International comparison of the speed of population aging

Country	Year in which the aged population reaches		Time required to increase from 10 to 20% (years)
	10%	20%	
Japan	1984	2005	21
Canada	1984	2024	40
Italy	1966	2007	41
Greece	1968	2019	41
Finland	1973	2015	42
Spain	1975	2017	42
Australia	1985	2030	45
Netherlands	1969	2019	50
U.S.A	1972	2028	56
Switzerland	1959	2019	60
Germany	1952	2012	60
Denmark	1957	2018	61
Sweden	1947	2012	65
Norway	1954	2022	68

Sources: United Nations, *World Population Prospects: The 2000 Revision*, New York, 2001. Data for Japan are based on the NUPRI population projection.

Table 4. International comparison of the projected familial support ratio in 2005

Country	Women aged 40-59 / Those aged 65-84
Japan	0.78
Greece	0.78
Italy	0.81
Bulgaria	0.93
Germany	0.84
Sweden	0.89
Portugal	0.90
France	0.97
United Kingdom	0.99
Switzerland	0.98
U.S.A	1.34

Sources: United Nations, *World Population Prospects: The 2000 Revision*, New York, 2001.
Data for Japan are based on the NUPRI population projection.

Table 5. Projected changes in selected economic and social security-related variables, Japan, 2000-2025

Year	Real GDP* (trillion yen)	Labor supply (million)	Gross national savings rate** (per cent)	Male contribution rate for ESP (per cent)	Total medical expenditure (billion yen)	Social security contributions + taxes / national income (per cent)
2000	488.9	67.7	14.4	17.35	30.4	38.0
2005	537.5	67.7	13.3	19.85	36.2	39.3
2010	591.7	66.3	11.5	23.21	43.3	40.9
2015	629.7	63.5	9.9	27.91	49.7	43.4
2020	649.4	61.7	8.1	29.43	54.8	45.0
2025	655.6	59.9	6.2	30.97	57.9	45.7

* 1985 constant prices

** Defined as 100* (personal savings + corporate savings + government savings) / national income

Table 6. Estimated number of elderly persons aged 65 and over who need assistance from other persons, 2000 and 2025

(Unit: 10,000 persons)

	Year		
	2000	2025	Annual growth rate (%)
Difficulty in working	1170.3	1713.7	1.54
Assistance needed for			
taking a bath/shower	124.4	325.5	3.92
dressing	93.2	242.2	3.89
eating	43.4	121.3	4.20
standing up from a bed or chair	67.9	171.3	3.77
going to the bathroom and taking care of necessary functions	65.0	175.8	4.06
leaving the home to purchase necessary items or medication	185.4	437.5	3.49
taking the bus or the train to leave home	218.4	519.6	2.38

Figure 1. Interrelationship among three submodels

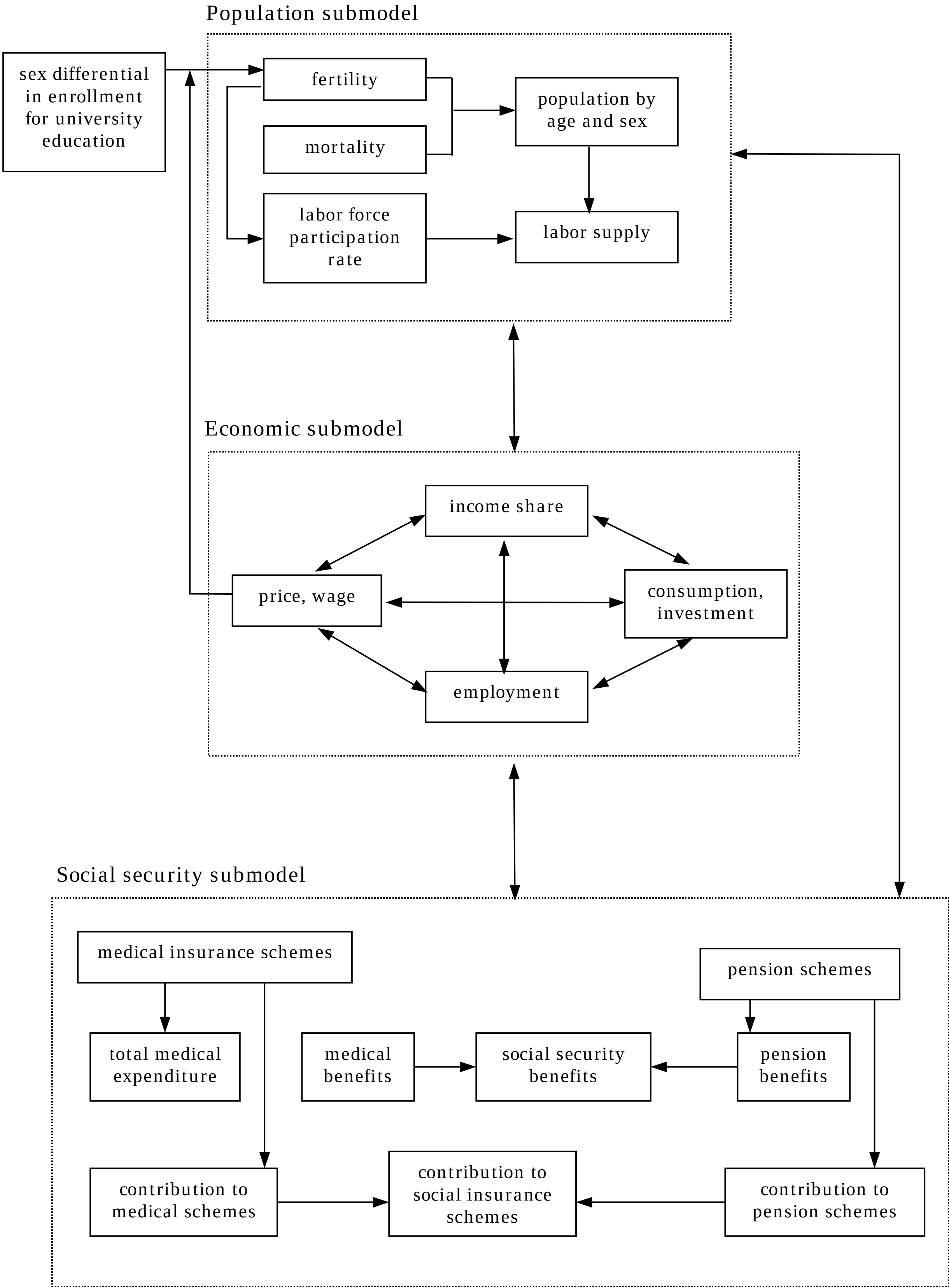

Figure 2. Framework for estimating fertility

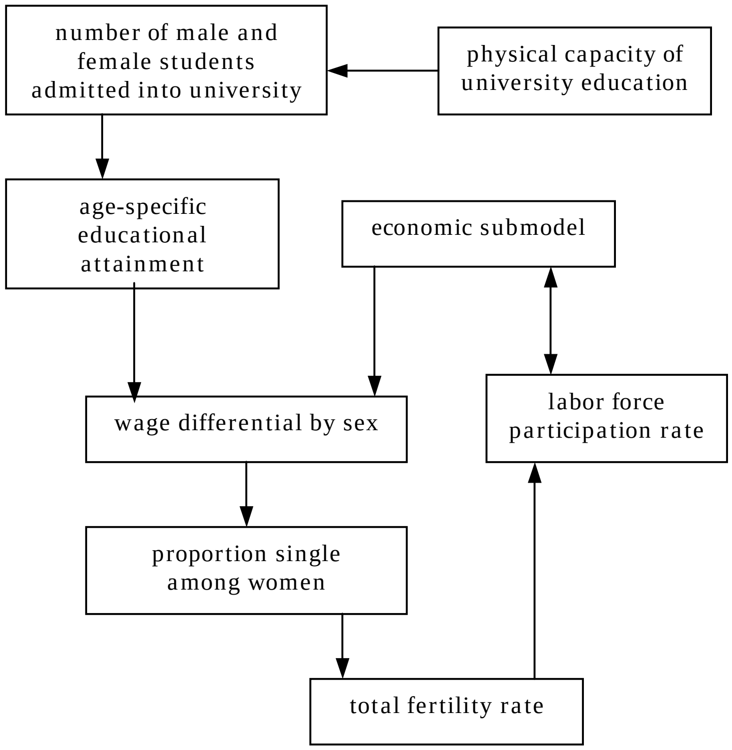

Figure 3. Actual values and values predicted by the Lee-Carter model

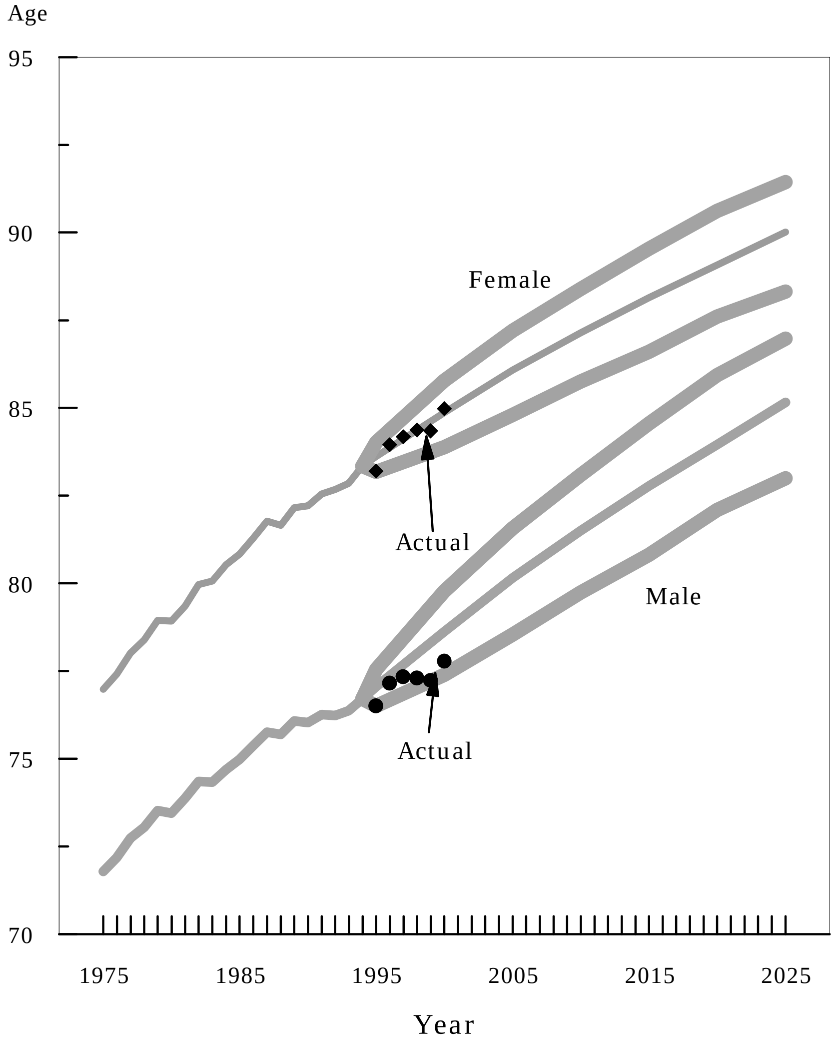

Figure 4. Projected life expectancy at birth for men and females, 2000-2025

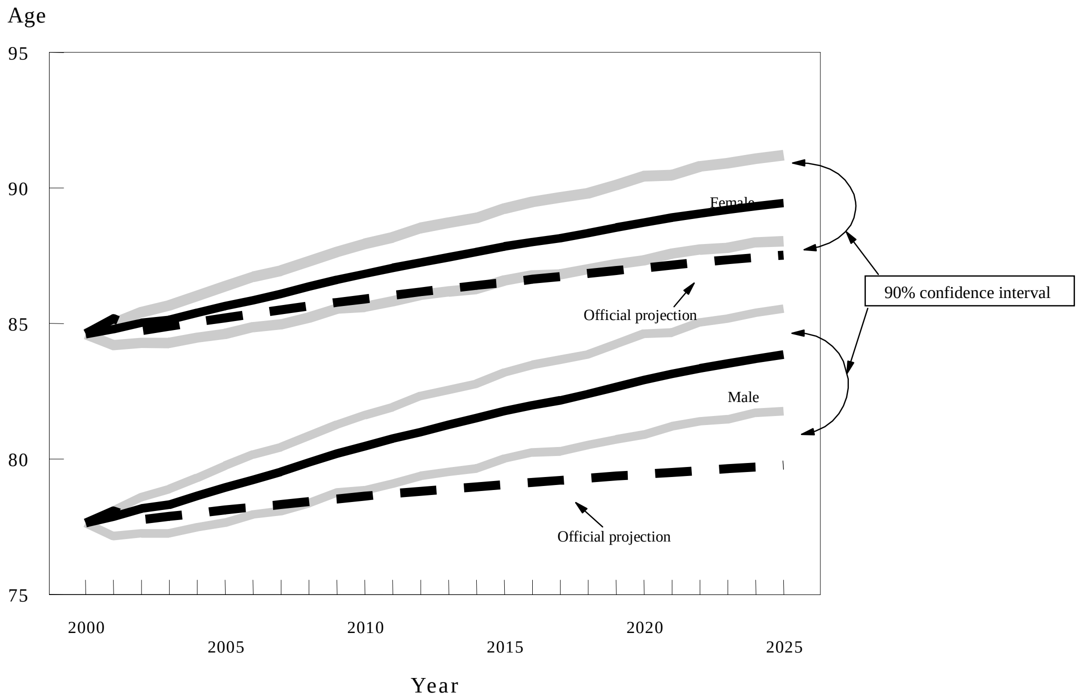

Figure 5. Projected "Surplus" of women aged 65 and over, 2000-2025

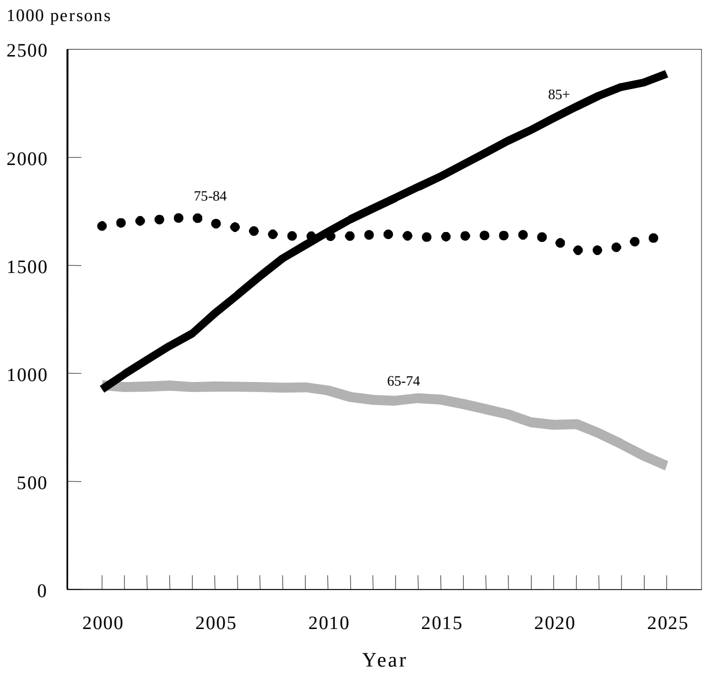

Figure 6. Number of centenarians, 1963-2025

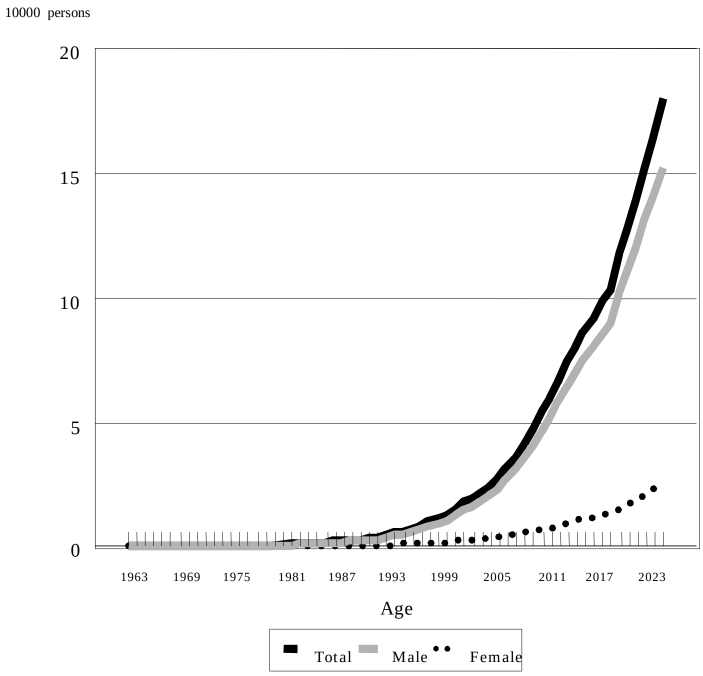

Figure 7. Change in the median age of male and female populations, 2000-2025

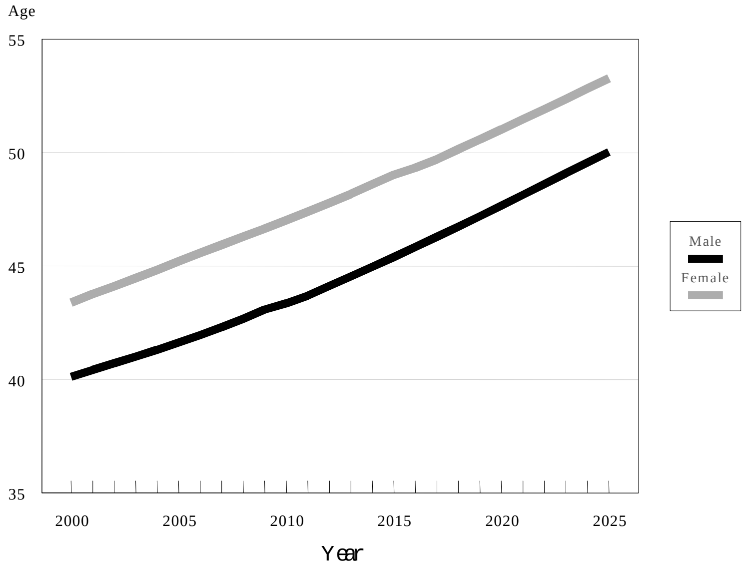

Figure 8. Projected male contribution rates to the ESP

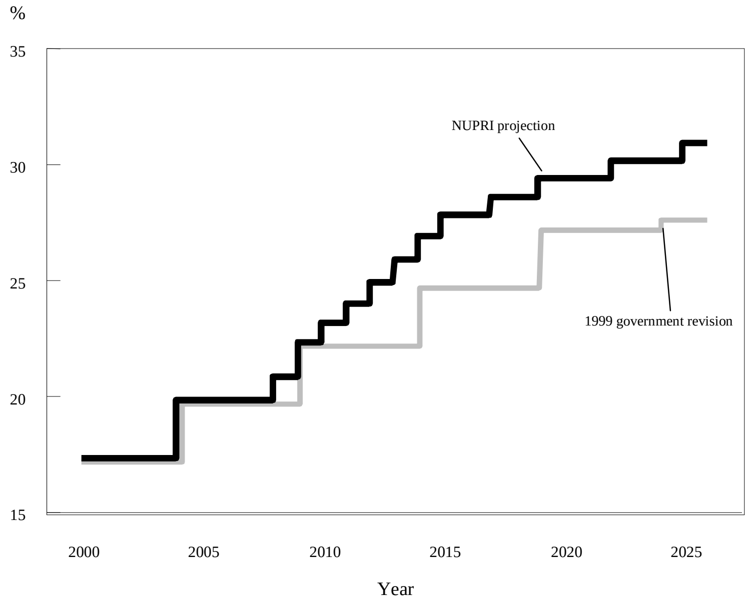

Figure 9. Projected change in the ratio of aged population suffering from senile deme
ntia or being bedridden to non-working women at various ages, 2000-2025

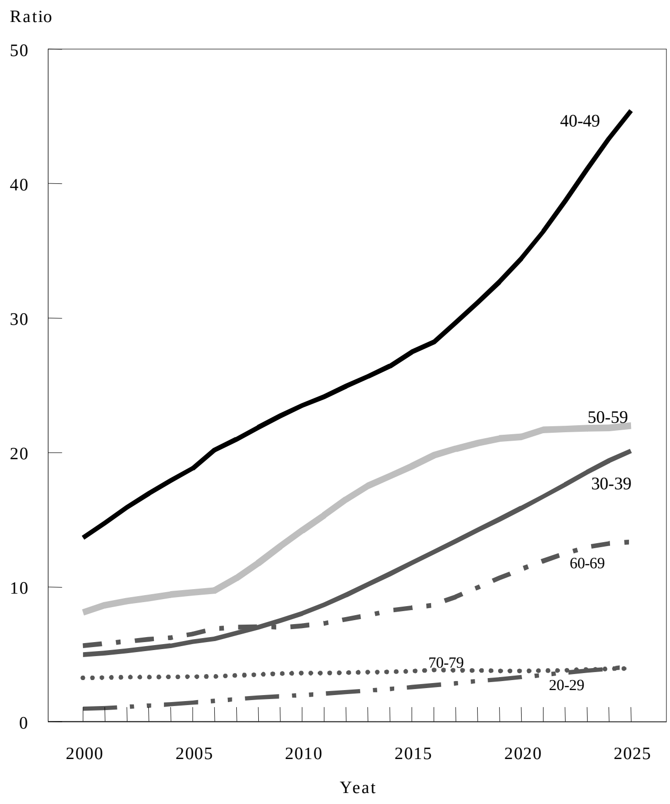

Figure 10. Redefinition of the age of elderly persons, 2000-2005