

Aging and Saving :

Will the Change of Age Structure Reduce Household Saving in Japan?

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Major paper presented to the

Department of Economics of the University of Ottawa

in partial fulfilment of the requirement of the M.A. Degree

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*Ottawa, Ontario*

*January, 2001*

## **Abstract**

According to the population projection estimates nearly 20 percent of the population will be 65 or over by 2007 in Japan. One of the consequences of this demographic trends is the possibility of a downward pressure on household savings as suggested by the life-cycle hypothesis. In this paper, we estimate saving functions for households in Japan, especially paying attention to the role of demographic structure. Generally, the results confirm that the savings rate vary inversely with the total dependency ratio, although not significantly. But the result also show that the increase in life expectancy may continue to stimulate household savings. This suggests that Japan, as the second oldest country in the World, may not have to worry about the possibility of its demographic trends putting downward pressure on household savings.

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Keywords: population aging, household savings, life-cycle hypothesis

## **I. Introduction:**

Population aging is a problem facing most industrialized countries. Japan, as a member of these industrialized countries, with its high speed population aging is specially getting a lot of attention. In the past decades, the Japanese population has already become the second (only Italy has a more elderly population than Japan) most elderly country in the OECD area, with a country average age of 40. According to the latest population projections by the National Institute on Social Security and Population issue, by 2007 over 20 percent population will be at least 65 years old, sooner than any other countries. The time needed for the portion aged over 65 to double from 10 to 20 percent of the population is projected to be only 22 years. As a result, the elderly dependancy ratio which is defined as ratio of those who are over age 65 to the active age population ranged from 15 to 64 has risen from 0.10 in 1930 to 0.22 in 1997, and it is projected to rise to 0.48 in 2025. By 2025, the average age of the population in Japan will be the highest in the industrialized countries, with about 45 years.(Appendix: Population Projection)

Population aging is expected to be a pervasive force affecting the structures of economies, through its impact on labor market, saving rate and capital accumulation, etc. The most direct channel by which demography affects economy is through the labor force market. While the elderly population is increasing, the younger population is declining and this has already led to a reduction in the working-age population. The change in the share of the working- age population can have large effects on a country's growth rate (Bloom and Williamson,1998). In the case of East Asia, Bloom and Williamson attribute 30 to 40 per cent of the economic growth to the demographic effects (positively). Obviously, aging population reduces the labor supply, which might have negative effects to the economic growth. In Japan, for the first time in its modern history, the labor supply is expected to decrease, after peaking at 68 million in 2001. Also, Japan's age composition of the labor force will shift dramatically. In 1995, the ratio of the male labor force aged 15-24 to that aged 60 and above is roughly 0.8, but this is projected to fall to 0.5 in 2009, when the baby boommers reach 60. However, population aging may be tolerated by increasing capital inflows and accelerating technical changes as firms respond to an increasing scarcity of labor (Cutler, Poterba, Sheiner, Summers,

1990). Population aging might also decrease savings. A simple life-cycle model of consumer behavior assumes that significant dissavings by the elderly, which means elderly run down their stock of assets following the retirement. In Japan, national saving rate is projected to decrease substantially over time, to 8 percent of income by 2025. Even this is still a high saving rate to other industrialized countries, to Japan, whose saving rate was 13.2 percent in 1997, the change will be significant.

The purpose of this paper is to examine the relation between aging and saving, especially we investigate whether the saving rate will be significantly affected by the aging of the population in Japan. Numerous studies have examined the relationship between age and saving using both micro and macro data (Weil, 1994). The opinions differ regarding to the question of whether the saving rate can be understood purely in terms of the life-cycle hypothesis—the idea that people save during their productive years for retirement, which means elderly dissave. The microeconomic data on household saving behavior in many studies appear to be inconsistent with the life-cycle hypothesis. The conclusion based on this level leads to that elderly do not dissave significantly, while the estimations by using the aggregate data have shown that the population aging will leads to a lower saving rate. In this paper, we examine the relation between population aging and household savings in Japan with annual time-series data. We give the empirical results of these two variables, and other explanatory factors. The model used first to test this hypothesis is from MacKellar and Wakabayashi (1999) which is originally from Qian(1988), and then we use the model from Fougère and Mérette (2000) to test the same hypothesis .

The paper is organized as the following: in the section two, we give a brief description of the current aging population situation in Japan. In the third section, we try to answer the question that why Japan has relatively high level of saving rate compare to other industrialized countries, especially the U.S. The section four reviews some literature on the studies of relationship between aging and savings. The section five introduces the model in details. The empirical implementations are presented in the section six, and at the end of the paper, by interpreting the empirical results, we derive the conclusion.

## II. Demographic Trends

The aging problem has been attracting a great deal of attention since decades ago, both in the developed and developing countries. However, comparing with the developing countries, the developed countries are experiencing earlier demographic transitional period to the aging society. The proportion of the elderly persons in the developed countries is projected to increase dramatically in the following years. Table 1.1 presents historic and projected population age composition for the United States, Japan, Germany, Sweden, France and Canada.

**Table 1.1**

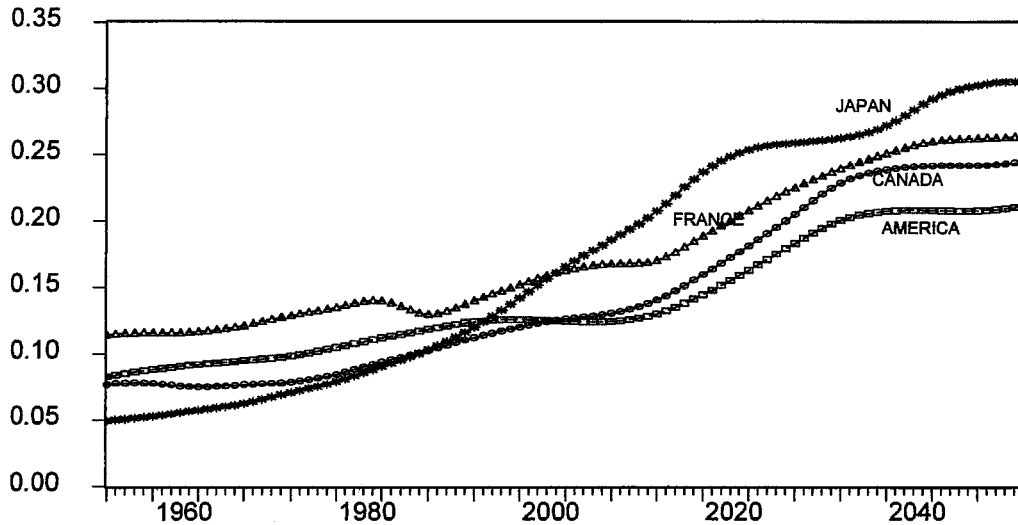
### **Historical and Projected Population Age Structure for Six Developed Countries : 1980-2025**

Country	1980			2000			2025		
	0-14	15-64	65+	0-14	15-64	65+	0-14	15-64	65+
United States	22.5	66.28	11.19	21.38	66.19	12.43	19.61	62.44	18.31
Japan	23.6	67.4	9.04	15.15	68.31	16.54	13.82	60.28	25.9
Sweden	19.6	64.12	16.29	19.07	64.25	16.68	18.27	60.14	21.59
France	22.2	63.75	13.97	18.34	65.41	16.24	16.36	61.14	22.5
Canada	22.7	67.91	9.39	19.28	68.12	12.60	17.48	62.01	20.51

*Source:* World Population Prospects 1950-2050 ( the 1996 revision). Data from 1950-1995 are United Nations demographic estimates, data for the 1996-2050 are from the United Nations Population Division's medium variant population projection.

**Graph 1.1.**

**International Comparison: Ratio of 65 Years Old and Over among Total Population (1950-2050 )**



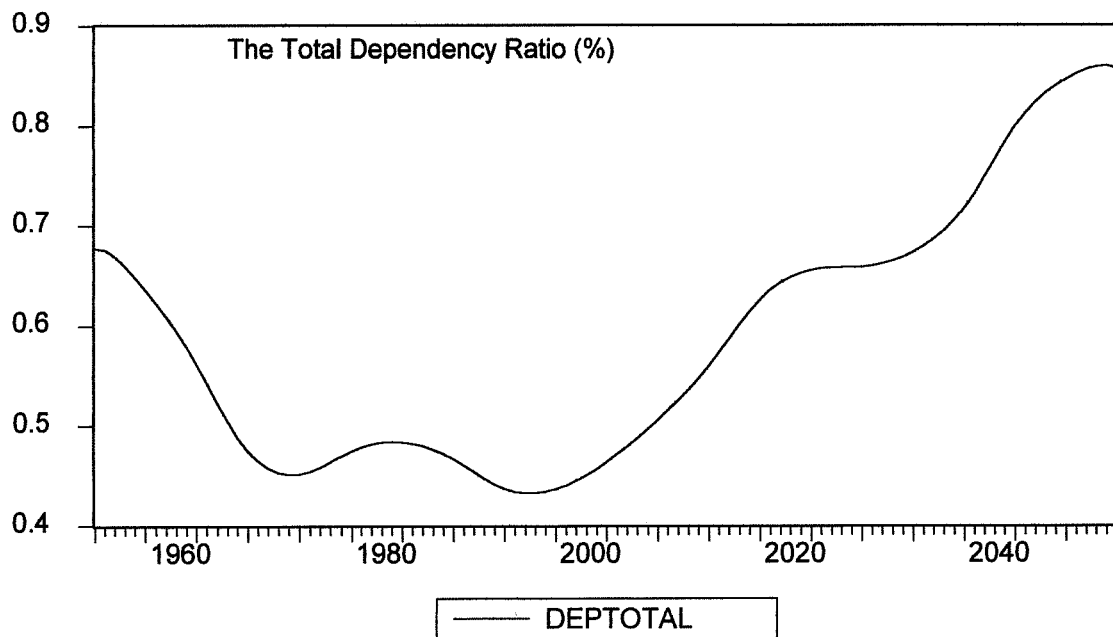
*Source:* World Population Prospects 1950-2050 ( the 1996 revision). Data from 1950-1995 are United Nations demographic estimates, data for the 1996-2050 are from the United Nations Population Division's medium variant population projection.

The Table 1.1 and Graph 1.1 show the substantial differences in the patterns of population aging among these countries. For example, in the U.S., children shared 22 percent of the total population in 1980, and 11.19 percent of the population was 65 or over. By 2025, children will represent 20 percent of the total population, people over 65 will rise to 18.31 percent. Similar pattern applies in Canada. But in the case of France and Sweden, by 2025 approximately 23 and 22 percent of their population will be 65 or older.

Among these developed countries, Japan has very unique pattern of population aging by its extraordinary high speed of population aging , and its high portion of the people over 75 years old. Until 1990, Japan had the lowest proportions of persons 65 and over. However, according to the latest population projections by the National Institute on Social Security and Population issue, by 2007 over 20 percent population will be at least 65 years old, sooner than any other countries. The time needed for the portion aged over 65 to double from 10 to 20 percent of the population is

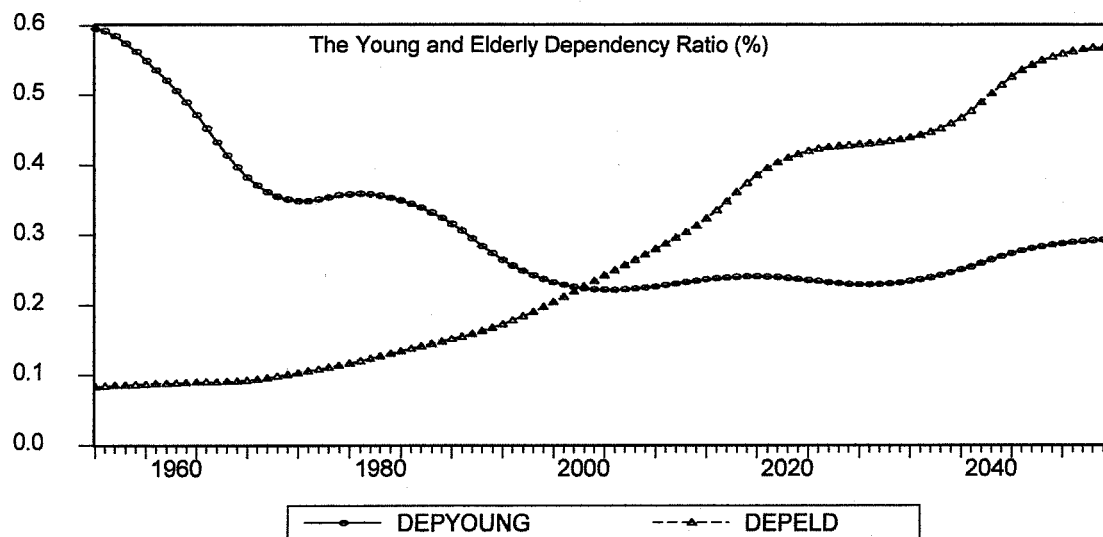
projected to be only 22 years. In the meanwhile, comparing with other countries, Japan has high portion of the people aged over 75 among elderly. The ratio of the population aged over 75 to those aged over 65 is projected to increase from 40 to 57 percent between 1995 to 2025. The population over 85 is projected to grow even faster than the population aged 65 to 84. Right now, Japan can be characterized as on the transitional period to the fully aging society. Also the year 2007 is the year when the baby boom generation will reach to retirement age, after this due to the declining of the work force, the total dependency ratio, which is defined as the number of children plus elderly as a fraction of the working age population aged from 15-64 ,will increase significantly (see Graph1.2 and Graph 1.3.). The harsh reality tells us that Japan's population is aging faster than that of any other country in the world.

**Graph 1.2. The Total Dependency ratio: 1950-2050 (%)**



*Source:* Japan's Statistical Yearbook,2000.

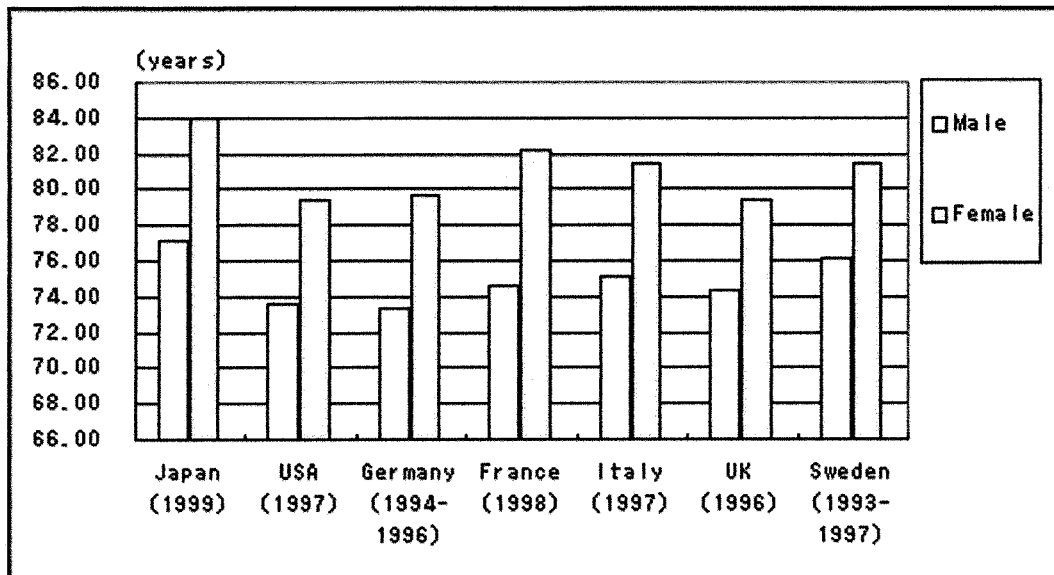
**Graph 1.3. The Young and Elderly Dependency Ratio : 1950-2050 (%)**



*Source:* Japan's Statistical Yearbook, 2000.

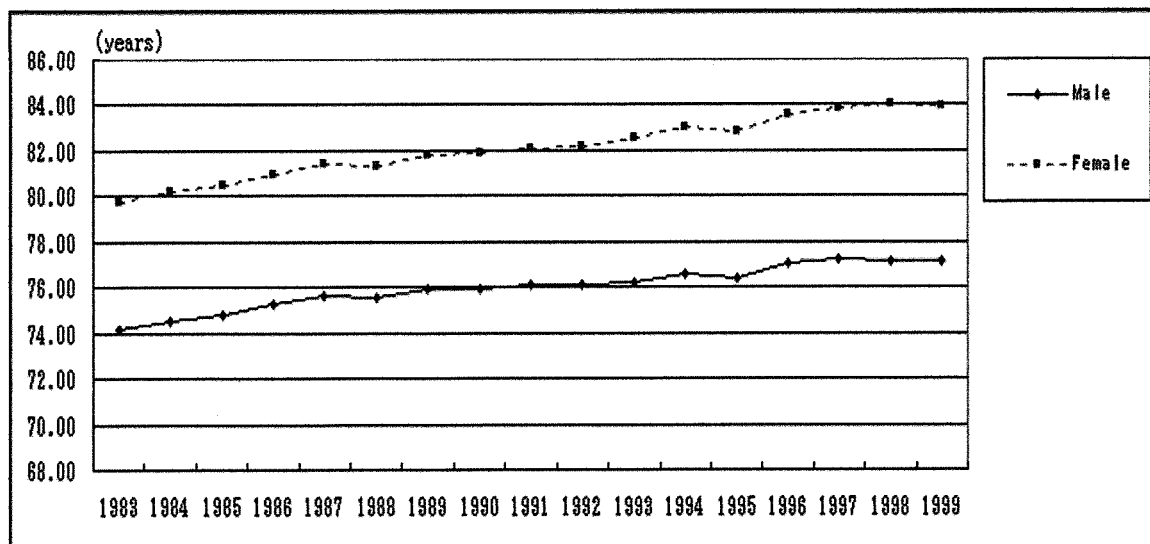
Japan's demographic problem has its roots largely in longer life expectancy and its decreasing fertility. Just 50 years ago, Japanese people could expect to live an average of 59 years, while in the U.S. it was about 66 years old for American male. But today, the average life expectancy in Japan is the longest in the world (see Graph 1.4.), standing at 76.36 years for men and 82.84 from women, average of about 78 years old. In the U.S. the average is about 74 years old. The rapid improvement in Japanese survival is given in Graph 1.5., which shows the life expectancy of life for various years for Japanese males and females. The rapid increasing of life expectancy in Japan can be attributed to many causes: improving of economy, rising of living standard, government sponsored public health programs, and technical advances. Here we need to mention that although in most developed countries, the declines in fertility rates during the 1970s are primarily responsible for the population aging, in Japan's case, from its high speed of population aging, we suggest that population aging is most sensitive to declines in mortality at the older ages (Ogawa, 1997).

**Graph 1.4. Average Life Expectancy in OECD Countries**



Source: OECD Economic Surveys, 1997.

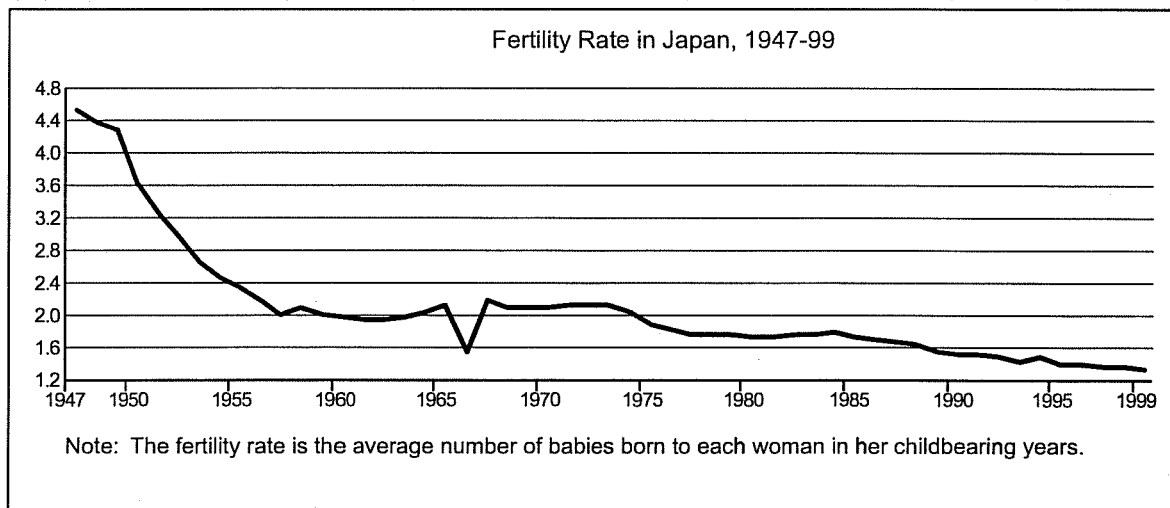
**Graph 1.5: Improvement of Life expectancy in Japan: 1983-1999**



Source: Ministry of Health and Welfare, Statistical Information Department, 1999.

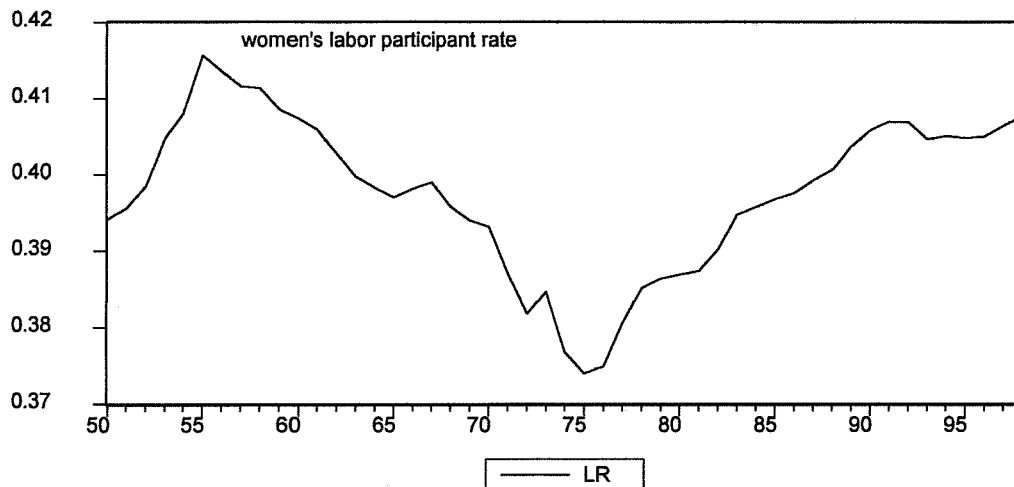
Although increasing life expectancy is the major factor in aging population in Japan, reductions in fertility rates is also important. Unlike the U.S. which had over 17 years baby boom from 1947 until 1964, the Japanese baby boom was very short from 1947 to 1949. Between 1947 and 1949, Japan had a large number of birth at about 2.7 million a year. After 1949, Japanese fertility went down by 50% in ten years time, which was the first time that such a drop in fertility rate happened in the history of mankind. The reasons of the declining fertility rate are very different from the period before 1970 and after 1970. Before 1970s, Japan's economy was in the developing course, especially, right after World War Two, Japan was in its worst shape at the time, and the fertility was reduced by abortion. According to the statistics, the three-quarters of pregnancies in the first half of the 50s were ended up in abortion. Another dramatically dropped of the fertility happened in 1966, which is called the year of the fire horse in Japan (*hinoeuma*, happens once in 60 years). According to Japanese superstition, girls born in that year will most likely have very unhappy lives, and their husbands will die before them. This is the reason people avoid birth. They either had babies the year before or the year after. Even though the total fertility rate recovered to reach the replacement rate after 1970, the recent decline of the fertility rate in Japan is the result of the increase in the women's labor participation rate and level of education. Graph 1.6. shows the demographic trends in Japan through 1947 to 1999. Graph 1.7. shows the change of women's labor participation rate.

**Graph 1. 6: Demographic Trends in Japan : 1947-1999**



Source: Ministry of Health and Welfare, 1999.

**Graph 1.7. The change of women's labor participation rate: 1950-1998 (%)**



*Source:* Japan's Statistical Yearbook, 2000.

As illustrated in Graph 1.6., the trends in the total fertility rate of Japan since 1950 is unique. It fell rapidly between 1950 and 1957 from 3.65 to 2.04 birth per woman, and then remained a nearly steady level until 1974 except for a temporary dramatically drop in 1966. After 1974, the total fertility rate started falling again, to 1.5 in 1990, and 1.4 in 1999.

The Graph 1.7. shows that the proportion of women in paid employment has increased steadily. Ogawa and Ermisch (1992) show that the increase in the proportion of Japanese women in paid employment has been the most significant one in the developed countries. Higher education leads to higher salary, this draws more and more women enter paid employment. High wages also have been shown positive effect to the married women working full-time. Ogawa (1997) shows that the rate of return on education is 60 percent for women and 20 percent to men in Japan. The high education level and high participation rate to the labor force keep Japanese women stay in single longer than before. According to the 1995 population census, 50 percent of women in their late 20s are single. This was even higher than in the U.S. The average age of first marriage for women is 27.7 and that for men is 30.7.

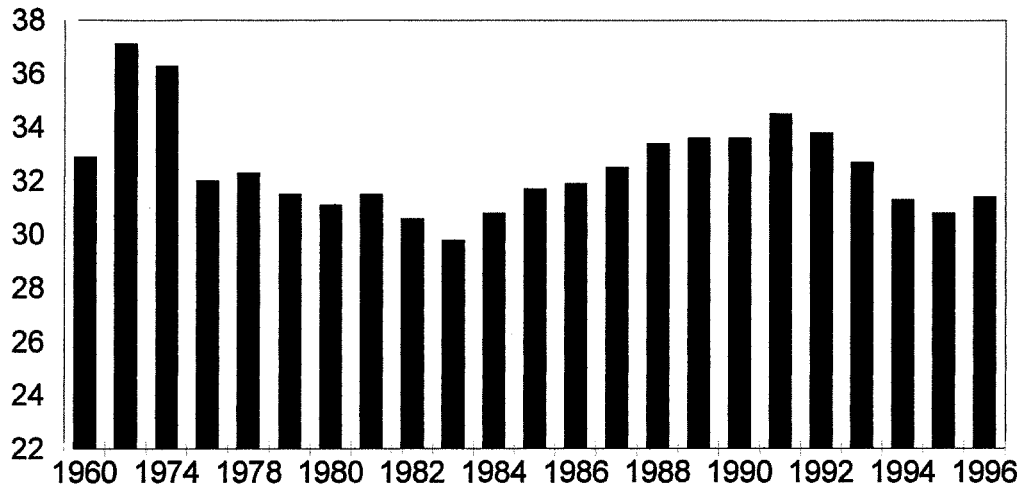
As we have seen from above, the aging population in Japan is raising dramatically. This implicates that the aging population has been expecting to affect the structures of Japan's economies through various ways, for example, through its impact on labor market, the investment and the

saving rate, etc. One of these crucial variables is household saving. Traditionally, household saving is explained by the life-cycle hypothesis, which says that the households is predicted to accumulate assets during the prime working years, then draw them down after retirement. This implicates that the proportion of income is saved by households is low in the twenties, gradually rise from thirties into forties and peak in the fifties, after it declines and become negative. Although the theory seems to fit the Japanese experiences, the size of this effect has been questioned. Some economists suggests that household saving decisions are dominated by the bequest motive which is the desire to leave an inheritance for the future generations. Deciding which hypothesis is the best for Japanese is very important. If we say that household saving in Japan can be explained by life-cycle hypothesis, that means that older population would have important negative consequences for the saving rate. In contrast, if the bequest motive predominates in the household saving decisions, the saving rate should be relatively unaffected by the aging of the population. In order to determine which hypothesis can be used to Japan's experiences, in the next section Japan's household saving pattern is examined.

### III. Saving in Japan

Japan's high domestic saving rate has been attributed to its rapid economic development after the World War Two. The Graph 2.1 gives the domestic saving rate since 1960 until 1997.

**Graph 2.1. The Domestic Saving Rate in Japan: 1960 to 1997 (%)**



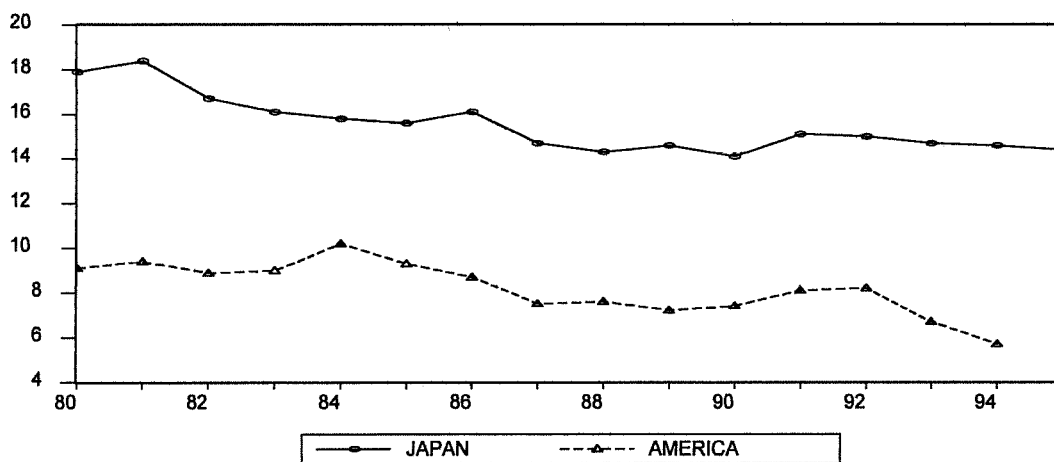
*Source:* Japan's Statistical Yearbook, 2000.

Japan's postwar strong saving, particularly household savings, has been provided the funds for corporate investment which was the critical point for the rapid economic growth of the Japanese economy over the postwar period. This has permitted Japan, unlike many developing countries, to avoid relying on the massive foreign investment in order to finance its domestic investment. During the mid-1970s, although the first oil shock reduced the corporate sector's demand for funds from the households sector, the continued relatively high level private savings was provided in 1980s, and this made Japan's net saving more available for investment oversea. The large flow of Japanese oversea investment attracted a lot of attention in the world. Especially in the U.S., it triggered Americans' anxiety. It seems that one day Japanese would own the whole country. Since then, the Japanese example has received an extraordinary amount of attention from the mass media, academics, and policy makers. Also, Japan's experience has provided a policy lesson for many countries, especially in the U.S.. It is widely believed that reduction of the fiscal deficit and increase

of household and private savings would lead to a positive current account balance, economic growth, and strong international competitiveness. Decreased net borrowing by the corporate sector and increasing net saving by the government in the light of continued relatively high level household saving led the Japanese current account surpluses getting larger and larger in the 1980s. Although after the burst of its bubble economy in 1990s, Japan's government balance turned into deficit, the private saving has been increasing steadily. Especially after 1992, the decline in interest rate has not been conducive to relatively lower savings as expected.

Among the industrialized countries, except Italy, Japan has the highest household saving ratio. It is almost twice the level of Americans' household saving rate. This can be seen from the Graph 2.2. below.

**Graph 2.2. Comparison of the household saving rate in the U.S. and Japan :1980-1995**



Source: OECD Economic Survey, 1990-1999.

Why Japan's saving rate is so much higher than other developed countries? Numerous studies have been done under this topic. While there are a number of explanations for the high saving ratio of households, opinions differ about the relative importance of the various determinants. For example, traditionally, the saving behavior is seen as a virtue in Japan. Other factors that contribute to high household savings in Japan can be the preparation for the retirement, high housing prices, high costs of education, bequest motivation, etc. (Horioka, 1999).

## *Saving for the Retirement*

Although the motivation of preparing for the retirement is also true to the U.S. household saving motivation, the role of this motive is more important in Japan than in the U.S. (Horioka, 2000). The weak social security system in Japan explains that difference..

The establishment of a comprehensive public social security system in Japan, incorporating pensions and insurance for the whole nation, came in 1961. The system expanded enormously in the 1970s during the period of rapid economic growth, which created new demand for social security among people. In the early 1970s, the Government adopted several measures to meet these demands, including increases in medical insurance and pension benefits, improvement in unemployment insurance and the introduction of child allowance. Current existing Japan's social security system includes both old-age pension schemes and medical plans, as well as unemployment compensation and other smaller programs.

The social security expenditures accounted mainly for pension benefits and medical benefits. However, the share of this two components has changed substantially over time. Pension benefits and medical benefits respectively accounted for 22 and 57 percent of total social security expenditures in 1965, and 51 and 38 percent of such expenditures in 1995. The shift from medical benefits toward pension benefits has occurred mainly because of population aging. While between 1965 and 1995 social security expenditure has increased from 6 to 16 percent of national income, the contributions to social security increased only from 5 to 13 percent of national income (Social Security Agency, 1997). The difference between expenditures and contributions has been compensated by the general tax revenues. Although it is still low compared with other industrialized countries levels, this is mainly because of the ratio of people aged 65 or over in Japan's total population (14.4% in 1995) and pension maturity ratio (22.3% in 1994), which represents the proportion of pension fund members actually receiving pensions, are low (Social Insurance Agency, 1997). However, the social security expenditures are expected to increase sharply, as Japan's population of elderly people grows rapidly in the following years.

In one of the studies done by Disney (2000) examining the liability of public pension programs in OECD countries suggests that with population aging, and declining of the working population, existing pension arrangements in many OECD countries are too costly. It estimates that the present value of contributions less pension expenditure as percentage of GDP for Japan is minus 70 percent (the U.S. -23%, Canada -100%); and net financial liabilities as percentage of GDP was 11 percent in 1995, and it will be 317 percent in 2030 (the U.S. 51% and 95% respectively; Canada 70% and -27% respectively). Also, projected increase in tax/GDP ratio to keep net debt constant is 9.6

percent in 2030.

As we know, during the early stages of a social security system, the discrepancy between contribution and benefits payouts does not arise, because no one has contributed for very long, so that contributions vastly outnumber beneficiaries at any given time and reserve funds increase. As the system matures, the proportion of retirees receiving pension benefits increases, and average pension benefits also increases as the average number of years of pre-retirement contributions lengthens. Japan's social security system is rapidly approaching maturity. In 1975, there were just over 22 active worker to support each elderly receiving a pension. At present, the ratio is just four workers to one elderly and that figure is set to decrease even further. The Health and Welfare Ministry (1999) estimates that to cover the needs of the future age population, the pension premium in 2025 will have to amount 34.3 percent of a workers monthly income, up from the 17 percent of 1995.

In order to solve the financial problem, in December 1998, the Japanese government decided to freeze increase in social security contribution rates for the pensions from 1999, with a partial funding shift to general revenue from one-third to one-half in financing basic benefits from 2004 at the least. The funding shift will enable the contribution rate for the pensions to decrease by one percentage point for the principal program for private-sector employees, and by 3,000 yen (27 dollars) per month for each non-employee person. In July 1999, the government submitted the 1999 pension reform bill to the parliament and the bill passed it in March 2000. The main issues are as following:

- 1) Earning-related benefits are to be reduced by 5 percent; specially, the current annual accrual rate of 0.75 per cent is to be decreased to 0.7125 percent from 2000.
- 2) The normal pensionable age for earning-related old-age benefits is to be increased step by step from age 60 to 65 for men from 2013 to 2025.

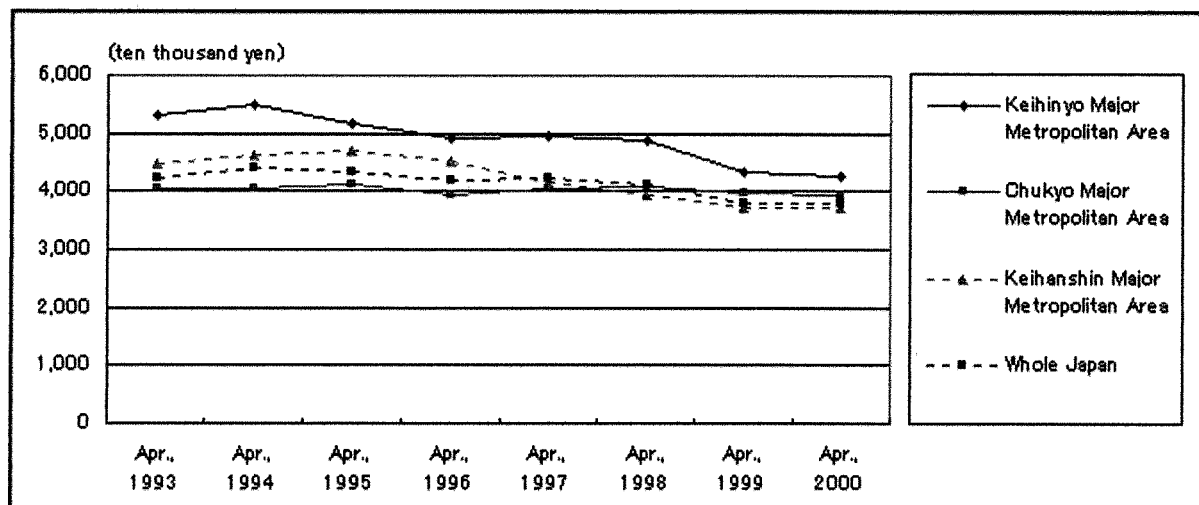
By these measures, aggregate pension benefits will be reduced by 20 percent by 2025. As a result, uncertainty to the future liability of the social security system make Japanese save large part of their income for the retirement.

Long life expectancy is another reason that Japanese household saving for their retirements. As we have studies in the section two, average life expectancy greatly increase from 50.1 in 1947 to nearly 80 in 1999. While expecting living longer than before, without reliable social security system, people tend to save more while they are active.

### *Saving because of the High Housing Cost*

Another important factor to explain the high household saving is the high housing costs in Japan. The purchase of land and housing has been frequently mentioned as an important motive for saving. Despite a significant decline since 1991, housing prices in Japan have risen more than 6 percent per year on average between 1955 and 1994. Compared with other OECD countries, the housing price is relatively high in Japan. For example, in Japan, a detached house which is defined as an individual house standing on its own plot, is around 442,000 American dollars, which is 15.5 times the average annual household income; while in the U.S., the house costs about 100,300 American dollars, which is about 3.9 times the average earnings. For the capital cities, the differentials with Tokyo were even wider in 1991, especially for apartments. In 1991, a apartment cost 457,000 American dollars, which was about 13.5 times the average earnings. At the same time, the same apartment cost 140,200 American dollars in London, which was about 6.2 times the average earnings. Since 1991, the prices have fallen in Tokyo, however, similar declines have occurred in many OECD countries.

**Graph 2.3. Prices of Houses: 1993-2000 (Ten-thousand Yen)**



Price is posted price on advertisements include consumption tax (1993-1996 : 3 percent, 1997-2000 : 5 percent).

Keihinyo Major Metropolitan Area is the large urban zone centering the Special Wards of Tokyo Metropolitan, and Chiba, Yokohama, and Kawasaki Cities.

Keihanshin Major Metropolitan Area is the large urban zone centering Kyoto, Osaka, and Kobe Cities.

Chukyo Major Metropolitan Area is the large urban zone centering Nagoya City.

*Source:* Jutaku Shijo Kakaku Chosa (Price Survey of the Housing Market)  
The Housing Loan Progress Association (August 3, 2000)

However, although the survey shows that purchase housing is the important motive in household saving, the effects of high housing costs on the aggregate household savings is less clear. In some cases, the rising housing costs may cause households which are renting to abandon the plans to purchase homes and to reduce their saving rate. Also, the housing-related saving is usually offset by depreciation. According to one study (Horioka, 2000), the net amount of housing-related saving (gross saving minus dissaving in the form of depreciation of the housing stock) has been generally negative.

#### *Saving and Educational Costs*

Compared to other countries, the educational costs are relatively high in Japan. This is shown in the following table:

**Table 2.1.. Educational Expenditures by Parents, 1998 (American dollars)**

School		Educational Expenditures
Kindergarten	Public	1100
	Private	3700
Elementary School	Public	550
Lower Secondary School	Public	1200
	Private	8000
Upper Secondary School	Public	3000
	Private	7000

Note: Annual amount of expenditures per capita.

*Sources:* Survey of Expenditures on Education for Children, 2000.

In Japan, traditionally, family fully support their children until they finish their undergraduate studies. In order to get the kids into a good university, parents usually start paying high educational fee to their children since kindergarten. In addition to the educational fees, Japanese parents have to take responsibility for their children until they get married. Moreover, the wedding ceremony is also supplied by parents, which on average costs 1,600,000 to 2,300,000 yen ( 13,000 to 20,000 American dollars). This indicates that parents have to save money as long as they have children.

As suggested by the life-cycle model people primarily save for retirement purpose and other life cycle motives including the precautionary motives. From the results shown above, the life-cycle model may be more applicable in Japan than in other countries. This can also be observed from age specified saving rate,

**Table 2.2. Age-specific Saving Rate, 1995**

<b>Age of household head</b>	<b>Saving rate(1995)</b>
25 to 49	18.3
40 to 59	21.8
60 to 69	15.3
70 over	-0.8
<b>Overall saving rate</b>	<b>17.8</b>

*Source:* OECD Economic Survey.

We can see from that Table the saving rate for those over 60 was about 14 percent of income, which is less than those under 60. Also, the saving rate is negative for those over 70. As a result, the overall saving rate should be reduced by the increase of the proportion of elderly households.

#### IV. Previous Studies

Numerous studies have examined the relationship between age and saving based on the life-cycle hypothesis. Most studies have proceeded in three directions (Weil, 1994). The first direction has been to test directly the life-cycle hypothesis, by regressing the saving rate on the ratio of the population aged 65 and over to the working age population (Horioka, 1989). In this kind of study, generally it is found that there is a negative effect of a large elderly population on saving, which confirmed the life-cycle hypothesis. A second direction has been to look at the effect of young and elderly dependency ratios on the saving, paying particular attention to the interaction between demographic transition and saving in the course of the development (Leff, 1980). The third kind of papers does not directly examine age structure, but uses Social Security Wealth variables, which are highly related to age, to test its impact on the saving (Feldstein 1995).

As we have examined in the last section, the life-cycle hypothesis seems to be more suitable to Japanese household saving behavior. In this paper, we follow the first direction by adopting the life-cycle hypothesis to test the demographic changes on the saving in Japan.

A general specification for examining the impact of demographic change on saving is,

$$(1) \quad s = c + \beta_0 d + \beta_1 z + \mu_t \quad \mu_t \sim \text{i.i.d} (0, \sigma_\mu^2)$$

where  $s$  is the saving rate,  $c$  is the constant,  $d$  is a vector of demographic variables and  $z$  is a vector of other variables such as income, and  $\mu_t$  is an error term.

Table 3.1. summarizes the results of recent studies which have adopted such specification. Typically, panel data of several countries are used for these studies and demographic factor are represented by the dependency ratio. In these studies, some of them separate the elderly and young dependency ratio while others do not. Table 3.1. shows that most of the researchers have found significant negative associations between savings and demographic dependency ratio. Especially, the impacts of the elderly dependency ratio exceeds that of young dependency ratio. Based on these results, we expect that demographic trends in Japan will depress the households saving rate.

In this paper, we use the model of MacKellar and Wakabayashi (1999) to estimate the relationship between demographic trend and household saving in China. This model was originally used by Qian's(1988) to study the household saving behavior in China. Qian (1988) estimates two basic household saving models. One is the Absolute Income Model (AIM), the other is the Permanent Income Model (PIM).

In the AIM, based on Keynesian theory, there is a linear relationship between current saving and current income,

$$(2) \quad S_t = \alpha + \beta Y_t + \mu_t \quad \mu_t \sim \text{i.i.d} (0, \sigma_\mu^2)$$

where  $S_t$  is saving,  $Y_t$  is disposable income, and  $\mu_t$  is a stochastic error term. We can also rewrite the equation (2) for the average propensity to save (APS) as,

$$(3) \quad APS = S_t / Y_t = \alpha / Y_t + \beta + \nu_t \quad \nu_t \sim \text{i.i.d} (0, \sigma_\nu^2)$$

The features of the AIM model are that saving is only determined by current income, and the short-run and long-run rate of household savings to current income are identical.

In the PIM, savings are related to permanent income, which can be thought of as the steady rate of consumption a person could maintain for the rest of the life, like net wealth and income earned at current time and in the future. According to PIM, the impact on saving of income will depends on which kind of income shifts,

$$(4) \quad S_t = \alpha + \beta_p Y_t^p + \beta_t Y_t^t + \mu_t \quad \mu_t \sim \text{i.i.d} (0, \sigma_\mu^2)$$

where  $Y_t^p$  and  $Y_t^t$  are defined as permanent income and transitory income, with  $Y_t = Y_t^p + Y_t^t$ .

Qian (1988) follows the method used by Williamson (1968) which uses as a proxy for permanent income a three-year moving average of actual income, which is ,

$$(5) \quad Y_t^p = (Y_t + Y_{t-1} + Y_{t-2}) / 3$$

The features of the PIM is that the shift of permanent income will change household's expectations for their future income level, asset level and saving; however, a shift in transitory income might not have such impacts.

The model used by MacKellar and Wakabayashi (1999) adds the demographic variables to the Qian's Model (1988), estimates the household saving for both urban and rural area of China. which are,

$$(6) \quad S_t = \alpha + (\beta_0 + \beta_1 DepRate_{e_t} + \beta_2 DepRate_{y_t}) Y_t + \mu_t \quad \mu_t \sim \text{i.i.d} (0, \sigma_\mu^2)$$

( 7 )

$$S_t = \alpha + (\beta_0 + \beta_1 DepRate_{e_t} + \beta_2 DepRate_{y_t}) Y_t^p + (\beta_0 + \beta_1 DepRate_{e_t} + \beta_2 DepRate_{y_t}) Y_t^t + \mu_t$$

$$\mu_t \sim \text{i.i.d} (0, \sigma_\mu^2)$$

Where  $S_t$  is saving,  $DepRate_{e_t}$  is elder dependency ratio, and  $DepRate_{y_t}$  is young dependency ratio. The estimation results are in Table 4.2.

**Table 4.2. Estimation Results**

**Absolute Income Model**

Independent Variables	Coefficients (Urban)	Coefficients (Rural)
$Y_t$	0.3489 ** (0.049)	0.662**(0.089)
$DepRate_{e_t} * Y_t$	-0.0068** (0.002)	-0.019**(0.005)
$DepRate_{y_t} * Y_t$	-0.00073 (0.0005)	-0.00066 (0.0015)
Constant	-254.75** (86.4)	-367.9** (68.47)
R-Square	0.80	0.74

Standard Errors present in parentheses.\*\* denotes significant at the 99% confidence level.

### Permanent Income Model

Independent Variables	Coefficients(Urban)	Coefficients (Rural)
$Y_p$	0.2259** (0.0634)	0.6378**(0.149)
$DepRate_{e_t} * Y_t^P$	-0.0007 (0.003)	-0.0178* (0.0083)
$DepRate_{y_t} * Y_t^P$	0.00023 (0.0073)	0.00012 (0.0023)
$Y_t^t$	1.3911 **(0.387)	0.9006 (0.6419)
$DepRate_{e_t} * Y_t^t$	-0.0641 **(0.0214)	-0.0278 (0.0418)
$DepRate_{y_t} * Y_t^t$	-0.0102 (0.0055)	-0.0050 (0.0096)
Constant	-208.77 * (82.45)	-380.81 ** (78.385)
R-Square	0.82	0.74

Standard Errors are presented in the parenthesis. \*\* denotes significant at the 99% confidence level, \* denotes significant at the 95% confidence level.

Source: Wakabayashi M.and MacKellar L., 1999

Above estimation results show that both elderly and youth dependency ratios have a negative impact on the household savings. Compared to the young dependency ratio, the impact of the elderly dependency ratio is more significant. In PIM, transitory income effect household savings significantly more than does permanent income. The impact of household demographic structure appears to be mediated through saving out of permanent income in rural areas but transitory income in urban areas. Based on the LCH and the observation from section two and three, we expect negative sign for the net household income and elderly dependency ratio, and positive sign for the young dependency ratio in the AIM and PIM models.

## V. Model Specification and Data

As we have shown in the section two, Japan's working age population is projected to decrease after 2001, and the elderly dependency ratio will rise rapidly. On the other hand, Japan's young dependency ratio will continue to decline. The net impact of these trends on the aggregate household saving is uncertain. In this paper, first we estimate original life-cycle hypothesis- based saving function by using annual time series data ranged from 1980 to 1995. The equation is,

(1)

$$S_t = \alpha + (\beta_0 + \beta_1 DepRate_{e_t} + \beta_2 DepRate_{y_t}) Y_t + \mu_t \quad \mu_t \sim \text{i.i.d}(0, \sigma_\mu^2)$$

(2)

$$S_t = \alpha + (\beta_0 + \beta_1 DepRate_{e_t} + \beta_2 DepRate_{y_t}) Y_t^p + (\beta_0 + \beta_1 DepRate_{e_t} + \beta_2 DepRate_{y_t}) Y_t^t + v_t$$

$$v_t \sim \text{i.i.d}(0, \sigma_v^2)$$

where:  $S_t$  = net household saving  
 $DepRate_{e_t}$  = Proportion of population of 0-14 to the population 15- 64  
 $DepRate_{y_t}$  = Proportion of population of 65+ to the population 15-64  
 $Y_t$  = net household disposable income  
 $Y_t^p$  = Permanent income  
 $Y_t^t$  = Transitory income

Permanent income is calculated as a mean value of past three years current income. Transitory income is defined as current disposable income minus permanent income.

All data are from the *Japan's Statistical Yearbooks* of 1993-2000 and *OECD Economic Surveys* from 1972 to 1998. The household saving rate and household disposable income are from *OECD Historical Statistics 1960 to 1995*.

## VI. Estimation Results

### 1. Analysis of Stationarity

It is known that many economic time series have the characteristics of a random walk. Before regressing, we apply the augmented Dickey-Fuller (ADF) test to check whether the series are stationary or not. All the variables are tested for the period 1980 to 1995. The results are shown on Table 5.1.

**Table 5.1. ADF Test Statistics**

Variable	Level	First diff.
Log(Saving)	0.59	-2.79**
log(Y)	-0.79	-2.73*
DepRate(young)*Y	-3.26**	
DepRate(elder)*Y	-3.19**	
log(total DepRate)*Y	-0.57	-2.79*
log(Yp)	-0.18	-4.20**
Yt	-3.67**	
log(DepRate(elder)*Yp)	0.57	-3.97**
log(DepRate(young)*Yp)	-0.07	-3.36**
DepRate(elder)*Yt	-3.37**	
DepRate(young)*Yt	-4.15**	

\* Null hypothesis of unit root is rejected at 10% critical level, \*\* at a 5% level and \*\*\* at 1% level.



(2)

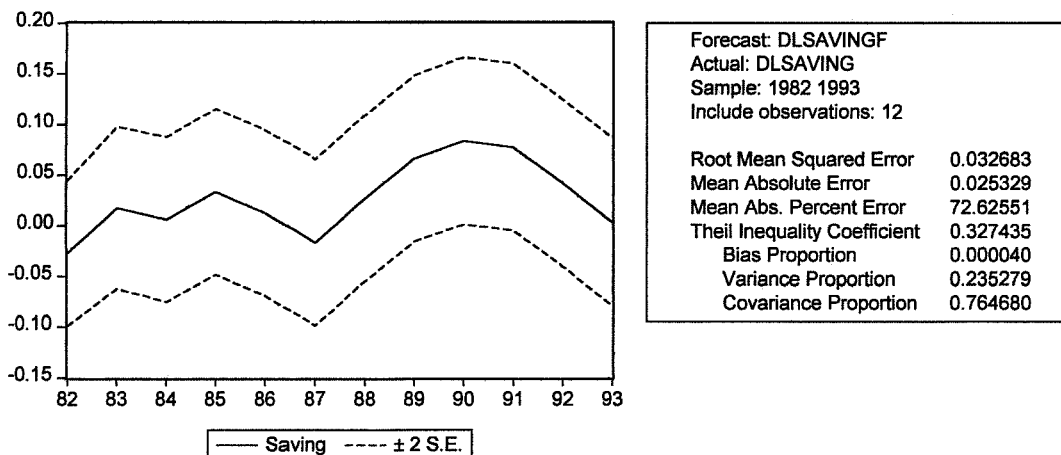
$$\Delta \log(\text{Saving})_t = -2.10 + 2.20\Delta \log(Y_t) + 0.17 \log \text{DepRate}_{total} * Y_t + AR(1) = -0.44$$

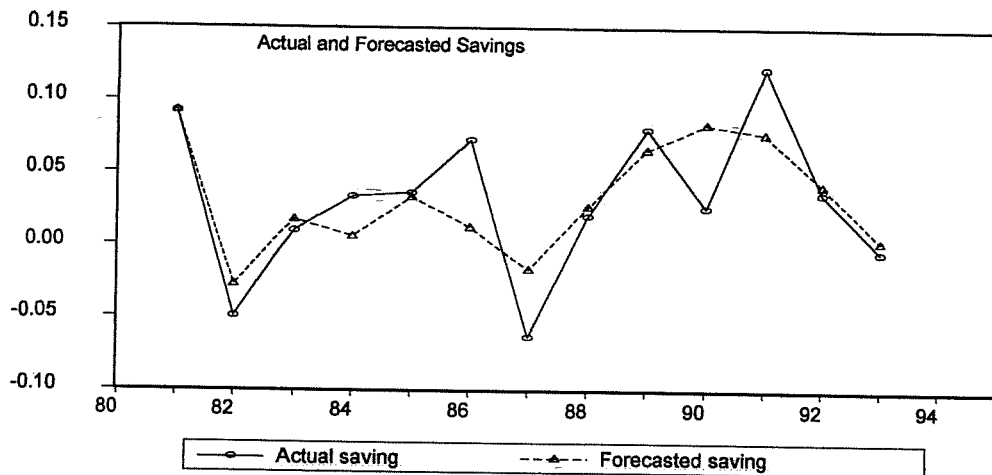
t                      -3.17                      3.2                      3.09                      -1.86

Adjusted R-Squared = 0.56      D.W.= 2.09      Q (2) = 0.25 (0.61)      Q(4): 6.86 (0.07)

Application of the statistic of LJUNG-BOX for 2 and 4 lags showed no preference of autocorrelation. According to equation (2), both current household income and the change of age structure of the population has been contributed to an increase in the household savings significantly during the sample period, which is inconsistent with LCH. Also, it indicates that young dependency ratio has had a greater impact on the household savings than the elderly dependency ratio during the last 15 years. However, as soon as the increasing share of the elderly dependency ratio begins to become the dominating factor in the change of demographic structure, the household savings will decline.

As it is shown on the AIM model evaluation graph below, although the covariance proportion shares the large parts bias, the variance proportion also shares the large part of the bias, which indicates biased and inconsistent estimation of the model. This can be confirmed by combining the actual and forecast value of household saving together.





The graph indicates that besides of current income and demographic factor, there might have other important variables that we should add to the model.

### 3. Estimation of the Permanent Income Model

The result of Permanent Income Model is presented below as equation (3),

(3)

$$\Delta \log(\text{saving}) = -0.14 + 5.06\Delta \log Y_t^p - 0.0001 \log(\text{DepRate}_{e_t} * Y_t^p) - 0.00009 \log(\text{DepRate}_{y_t} * Y_t^p)$$

$$t \quad \quad \quad (-0.29) \quad \quad (0.60) \quad \quad (-0.48) \quad \quad \quad \quad \quad (-1.01)$$

$$- 0.0017Y_t^t + 0.0038\text{DepRate}_{e_t} * Y_t^t + 0.00164\text{DepRate}_{y_t} * Y_t^t + AR(1) = -0.8$$

$$(-1.18) \quad \quad \quad (1.09) \quad \quad \quad (1.36) \quad \quad (-1.77)$$

Adjusted R-Squared = 0.46      D.W. = 3.4      Q (2) = 7.25 (0.01)      Q (4) = 14.4 (0.02)



The results of their paper are,

$$(6) \quad \log(S / Y_d)_t = 2.97_{(6.2)} - 3.9 \log(W_{-1} / Y)_t - 0.061_{(-9.8)} (Gbal / Y)_t + 0.052_{(4.3)} R_t + 0.09_{(9.3)} \pi_{-1t} \\ - 2.05_{(-4.9)} \log(AgeDep)_t - 0.49_{(-3.2)} \log((OAS + CQPP) / Y)_t + 0.024_{(5.1)} Gallup_t$$

Adjusted R-squared = 0.9      D.W.= 1.36      ADF = 6.9\*\*

\*\* Rejection of non-cointegration at 1% critical level.

According to the estimation by Fougère and Mérette (2000), there is significant negative impact of the net wealth on the saving; an increases in public sector deficits leads to an increase in personal savings; positive effect fo the real after-tax interest rate; total dependency ratio has significant negative impact on personal savings; a negative relationship between the ratio of public pension benefits relative to GDP and personal savings; uncertainty leads to an increase in the personal saving rate<sup>1</sup>.

Concerning of the importance of life expectancy in Japan, we add life expectancy variable instead of uncertainty. The model is modified as below,

$$(7) \quad \log(S / Y_d) = \beta_0 + \beta_1 \log Y_d + \beta_2 Gdef + \beta_3 \log(AgeDep) \\ + \beta_4 \log(SE / Y_d) + \beta_5 R + \beta_6 \log(lifeExp.) + \mu_t \quad \mu_t \sim \text{i.i.d}(0, \sigma_\mu^2)$$

where,

S            = household saving ratio

Y(d)        = household disposable income

---

<sup>1</sup> Notice that equation (6) is well specified because there is cointegration between the set of variable according to the ADF test applied to the equation.

Gdef = government deficit ratio of GDP  
 AgeDep = total age dependency ratio  
 SE = social security benefits  
 R = short term nominal interest rate  
 lifeExp. = average life expectancy

Before the regression, we apply augmented Dickey-Fuller (ADF) test to check whether the series are stationary or not. All the variables are tested for the period 1980 to 1995. The results are shown on the Table 5.2.

**Table 5.2. The ADF Statistic**

Variable	Level	First diff.
Log(S/Y)	-3.24**	
log(Y)	-0.79	-2.97*
log(lifeExp.)	-2.9**	
Gdef	-1.5	-2.7***
R	-0.81	-3.2**
log(AgeDep)	-0.18	-4.20**
log(SE)	-0.59	-3.9***

\* Null hypothesis of unit root is rejected at 10% critical level, \*\*at a 5% level and \*\*\* at 1% level

As shown in Table 5.2, except for household saving ratio and life expectancy, we cannot reject the presence of a unit-root for other all variables. However, the null hypothesis of nonstationarity is rejected for all variables in first difference level.

We first regress the equation (7) with all the variables in level form, results are presented below as equation (8),

(8)

$$\log(S / Y_d) = - 31.41 - 1.04 \log(Y_d) - 0.63 \log(AgeDep) - 0.012 Gdef - 1.54 \log(SE / Y_d) + 0.020 R + 6.97 \log(lifeExp.)$$

(-2.4)
(-1.9)
(-1.2)
(-2.05)
  
(-4.27)
(2.43)
(2.31)

Adjusted R-square = 0.85      D.W.=2.28    Q (1) =0.05 (0.81)    Q (2) = 6.65 (0.03)

According to the equation (8), a change in household disposable income has negative effect on the household savings, a 1 percent increasing in disposable income can decrease 1.04 percent of the saving rate, which is consistent with LCH. Unlike the results are given of the AIM and PIM model, the total dependency ratio has negative effect on the household saving rate, which means that 1 percent increase of the total dependency ratio leads to 0.6 percent of the reduction of the household saving rate. The government deficits has little effect on the household saving rates. Consistent with the findings of Fougère and Mérete (2000), we find the negative correlation between the ratio of social security benefits to household income and household saving rate, which suggests that 1 percent increase in the social security benefits relative to household income will cause 1.6 percent reduction of the household saving rates. As we suppose that short term nominal interest rate might cause some money illusion in the short run, we find that short run interest rate does have litter effect on household saving, this might can explains the relatively high saving behavior to the nearly zero real interest rate in Japan. This is also confirmed by the Wald's Test<sup>2</sup>, under the null hypothesis that coefficient of R is 0, the estimated value is significantly smaller than critical value. As a correction of the model, we omitted the R variable, it shows that adjusted R-squared is drop to 0.73, however, Durbin-Watson statistics improves from 2.28 to 2.12.

As we have mentioned before, the uniqueness of Japan's population aging is its highest life expectancy in the World. It can be argued that the households might save more before. With the increase in life expectancy are in the proportion of elderly, longer life expectancy might have positive impact on saving. This is confirmed by the estimation above, which shows there is significant positive correlation between life expectancy and household savings. It suggests that 1 percent increase of life expectancy would increase 6% of the household savings. This might can give the explanation of Japan's high saving rate in the industrialized countries.

However, we find that in the equation (8), except variables of saving ratio and life expectancy are stationary at their level, other variables are stationary at their first differences. As a result, we

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<sup>2</sup>The Wald test measures how close the unrestricted estimates come to satisfying the restriction under the null hypothesis.

correct the equation (8) by adopting the stationary forms of all the variables. The results are shown below as equation (9).

(9)

$$\begin{aligned} \log(S / Y_d)_t = & 20.68 + 1.98\Delta \log(Y_d)_t - 1.62\Delta \log(\text{AgeDep})_t - 0.02\Delta (\text{Gdef})_t \\ & \quad \quad \quad (4.9) \quad \quad \quad (2.28) \quad \quad \quad (-0.56) \quad \quad \quad (-0.84) \\ + 0.03\Delta \log(\text{SE} / Y_d)_t & - 0.02\Delta R_t - 4.91\log(\text{LifeExp.})_t \\ & \quad \quad \quad (0.94) \quad \quad \quad (-2.58) \quad \quad \quad (-4.3) \end{aligned}$$

Adjusted R-squared = 0.78

D.W.= 1.93

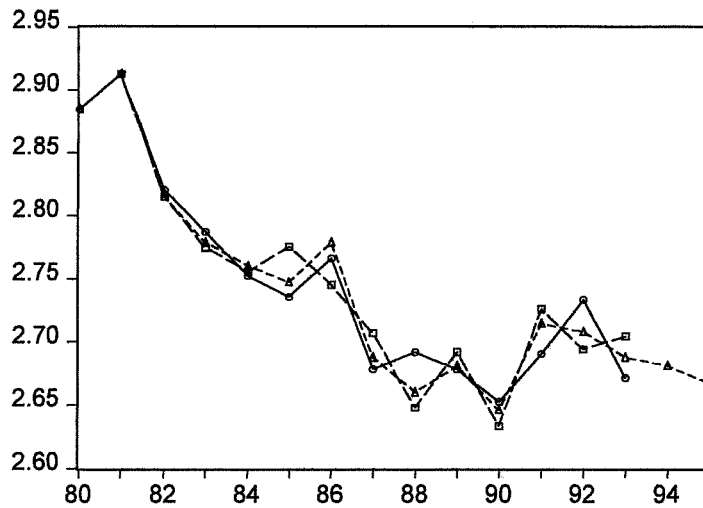
Q (1) = 0.07 (0.40)

Q (2) = 1.19 (0.55)

Q(4) = 5.81 (0.12)

Application of the statistic of LJUNG-BOX for 1, 2 and 4 lags showed no preference of autocorrelation. When we correct the model by using stationary forms of the variables, the results show the change of income has a significantly positive impact on the saving rate. However, the change of the age structure seems have little effect to the saving rate in Japan during the sample period. Unlike the result we have from equation (8), in the equation (9), it shows that life expectancy has significantly negative effect on savings.

Finally, we evaluate the model by using the in-sample dynamic forecast of the household saving rate for the model of equation (8) and error correction model of equation (9), and compare these two models to the actual saving rate, the results are shown as below,



— Error-Correction Saving Rate    - - - - Actual Saving Rate    - - - - Saving Rate of Equation (8)

Compared to the forecasted saving rate from equation (9), the forecasted saving rate of equation (8) seems track actual saving rate better. The evaluation of the equation (8) is shown below

Root Mean Squared Error	0.017554
Mean Absolute Error	0.015237
Mean Abs. Percent Error	0.560716
Theil Inequality Coefficient	0.003233
Bias Proportion	0.001628
Variance Proportion	0.001289
Covariance Proportion	0.997083

As we can see from the evaluation, the Theil<sup>3</sup> inequality coefficient is relatively small. Also, most of the bias is concentrated on the covariance part, which suggests the forecasting errors are due to the unsystematic errors. Also, we draw the actual and fitted value of the household saving ratio, we find the generally the two lines share the same trends. This indicates that compared to the AIM and PIM model, the alternative model can explain the household saving in Japan more completely.

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<sup>3</sup> The Theil inequality coefficient always lies between zero and one, where zero indicates a perfect fit.

## VII. Conclusion

In this paper, we have used the Absolute Income Model, the Permanent Income Model to estimate the relationship of demographic variables and income on the household savings. The parameters of the model are estimated by using Japan's annual time series data and data from other related studies. In the AIM model, we first incorporate separately in the regression the elder and young dependency ratio and we found although the signs of the parameters are consistent with life-cycle model, both young and elderly dependency ratio have little impact on the household saving rate. Then because of multicollinearity problem between young and elderly dependency ratio, we use the total dependency ratio. The results are inconsistent with the life-cycle hypothesis and indicate that the changing age structure of the population over last 15 years has increased the household saving in Japan. The estimation using the PIM model shows that permanent income positively contribute to an increase on household savings, while transitory income has negative impact on the household savings. In the short run, both elderly dependency and youth dependency ratio would positively influence household savings. However, the coefficients estimated by permanent income suggests that the increasing on both young and elderly dependency ratio will eventually cause the reduction of the household savings, which is consistent with the life-cycle hypothesis. We found the liability of the PIM model is low comparing to the AIM model.

Second, we used the model from Fougère and Mérette (2000), by adding social security benefit, government deficit variable, short term interest rate and life expectancy ratio. The result shows the increasing of total dependency ratio reduce the household savings, which confirms the life-cycle hypothesis. However the increasing in the life expectancy would increase the household saving significantly. This has important implication to Japan's future saving due to projected increasing in the total dependency ratio and life expectancy. As predicted by the LCH, the results from this paper support the hypothesis that population aging might lead to a reduction in the household savings, however, the expanded life expectancy might continue to increase household savings in Japan. As we know that there are lot of other factors effect household savings, such as net wealth and uncertainty that we did not include in the estimation. Further research would thus be appropriate.

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## Population Projections

[Medium-variant projections as of January 1997]

Year	Total (1,000)	Percentage by age group		
		Male	Female	Under 15 years 15 to 64 years 65 years and over
2000	126,892	62,121	64,771	14.7 68.1 17.2
2010	127,623	62,272	65,351	14.3 63.6 22.0
2020	124,133	60,300	63,833	13.7 59.5 26.9
2030	117,149	56,694	60,455	12.7 59.3 28.0
2040	108,964	52,680	56,284	12.9 56.1 31.0
2050	100,496	48,617	51,879	13.1 54.6 32.3

Source: Ministry of Health and Welfare.