# Adverse Impacts of Japan's Public Pension on Household Savings*

Narimasa KUMAGAI**

**Abstrsact**

This paper aims to investigate the adverse impact of public pension on household savings and to test whether public pension is subject to the Ricardian equivalence theorem in Japan. We reconsidered conventional framework for econometric modeling the inter-relationships between household savings and pension wealth. The magnitude of substantial reduction in household savings after 1974 is almost 1.6 times than before 1973 was revealed. On the other hand, through the test of the Ricardian equivalence theorem using GARCH-M model, two evidences were found. One is partial substitute relation between household savings and pension wealth. The other is the fact that conditional standard deviation of pension for the aged has been growing recently. From the latter finding, we might consider that the reliability for public pension scheme has been deteriorating.

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*Keywords*: Cointegration; GARCH-M; Japan; Public pension; Ricardian Equivalence; VECM

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** Corresponding author: Lecturer, Faculty of Economics, Fukuyama University, 985-1 Sanzo Higashimuramachi Fukuyama 729-0292, Japan.
E-mail: kuman@fuec.fukuyama-u.ac.jp

## 1. Introduction

There are some significant studies regarding the effect of Social Security benefits on household savings using the extended traditional life-cycle model since seminal paper, Feldstein (1974). On the other hand, modeling the long run when the variables are non-stationary has been developed during last two decade. From a statistical point of view, it seems that there are some problems with misspecification in the Feldstein (1974)'s type model. Thus, we reconsider conventional framework for econometric modeling the inter-relationships between household savings and pension wealth by time series model, which is Vector Error Correction Model (VECM) and Generalized AutoRegressive Conditional Heteroscedasticity in Mean (GARCH-M) model. In addition to measure the magnitude of the adverse impact of public pension on household savings using saving function and Cobb-Douglas production function, the reliability for public pension through the test of the Ricardian equivalence theorem are assessed in this paper.

The rest of this paper is organized as follows. In Section 2, some adverse impacts of public pension system on household savings are briefly discussed. In Section 3, using time series data, aggregated variables both net wealth of public pension for the aged and the annuity payment of working generation are defined. In Section 4.1, results of cointegration test based on unit root test, which is taking account of one exogenous structural break in data generating process, are represented. In Section 4.2, the inter-relationships between household savings and pension wealth are analyzed using VECM based on cointegration relationships. In Section 4.3, whether public pension is subject to the Ricardian equivalence theorem in Japan is tested by GARCH-M model, which can capture the risk premium of the annuity. Some final remarks are presented in the conclusion.

## 2. The adverse impact on household savings

In this section, some aggregate impacts of public pension system on household savings are briefly summarized. The introduction of public pension system can substantially alter the amount of lifetime savings. It is well known that such changes are the consequences of three effects. Those are (1) the retirement effect, (2) the wealth substitution effect and (3) the bequest effect. Taking account of above three effects at the same time, Feldstein (1974, 1982) found a positive and statistically significant value of 0.018 by econometric analysis. This positive sign suggests that increases in public pension wealth increase consumption and hence, decrease savings[1]. Thus, wealth substitution effect dominates the retirement and bequest effects[2].

As pointed out by Feldstein (1974), the existence of a public pension system will reduce household (private) savings assuming that the wealth replacement effect is larger than the induced retirement effect, and national savings will also be reduced if the pension system is a pay-as-you-go system. Empirical work on Japan using time series aggregated data has tend to find that public pension have reduced household savings (see, e.g., Nakayama (1997), Kumagai (2000, 2001))[3].

The other problem of Japan's current public pension system, which is the adverse impact on inter- and intra generational equity, is discussed in Horioka (1999).

### 3. Data

In this section, firstly, aggregate variables both net wealth of public pension for the aged and the annuity payment of working generation are defined. The latter is total expected public pension contribution per worker. Secondly, the variables used in the regression model are presented. It is the different point from Nakayama (1997) that pension for social welfare is not added into net wealth of public pension[4]. Public pension analyzed in this paper is constituted from two-type pensions. One is the old-age basic pension and the other is old-age welfare pension.

Data used to derive net wealth of public pension are as follows: Age structure, Pension contribution, Pension benefits, Survival rate, The number of public pension beneficiaries, The number of public pension participants, Total payments of public

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1) The estimate is a revision and update of the 1974 paper.

2) The retirement effect tends to increase private savings and to reduce participation in the labor force. Because of getting the right to receive benefits, public pension induces people to retire earlier than they would have. The wealth substitution effect means a reduction in the amount of total capital accumulation. If workers in working generation view contributions of public pension as a means of saving for their future benefits, they will tend to save less on their own. The bequest effect is as follows. Parents may save more to increase bequests to their children, and hence offset the distributional effect of public pension.

3) For a more detailed review on these studies, see Kumagai (2001).

4) Kumagai (2000, 2001) pointed out the problem in the calculation of this variable.

pension, Total transfer from national government[5)].

Age structure and Survival rate are each from The Report of National Census (every 5 years, Ministry of Management and Coordination) and The Table of Life Expectancy (Ministry of Health and Welfare and Labor). The rest of the data are from The Year Book of Social Security Statistics (Prime Minister's Office).

The Calculation of net wealth of public pension is as the following. Assume beneficiaries can start to get public pension at age 60 and lifetime is 100 years. Then, using the growth rate of pension benefits $g$, total expected pension benefit of a person whose age is $a$ at time $t$, can be represented as equation 1.

$$b_{at} = (1+g)^{60-a} b_t \qquad (1)$$

Equation 2 explains that public pension wealth of a person who is 60 years at time $t$ ($A_{60t}$). In which, $S_{ij}$ is the probability of survival rate of the age $i$ to the age $j$, $d$ is subjective discount rate[6)].

$$A_{60t} = \sum_{n=60}^{100} S_{60n} b_t \left(\frac{1+g}{1+d}\right)^{n-60}, \quad \frac{1+g}{1+d} = 1.02, d = 0.02 \qquad (2)$$

Public pension wealth of participants whose age is $a$ years at time $t$ ($A_{at}$) is defined as follows.

$$\begin{aligned} A_{at} &= S_{a60}(1+d)^{-(60-a)} \sum_{n=60}^{100} S_{60n} b_{at} (1+g)^{n-60} (1+d)^{-(n-60)} \\ &= S_{a60} \left(\frac{1+g}{1+d}\right)^{60-a} \sum_{n=60}^{100} S_{60n} b_t \left(\frac{1+g}{1+d}\right)^{n-60} \end{aligned} \qquad (3)$$

5) Public pension system in Japan is constituted from Employee's pension insurance, National pension, Government official's mutual benefit association, Local public service worker's mutual benefit association and others. Payments through the NTT mutual benefit association, the JR mutual benefit association and the JT mutual benefit association or their antecedent associations are included in Employee's pension insurance from FY 1997.

6) The variable g is about 4% (0.0404) to avert overestimating public pension wealth. The average disposal income per capita in Japan increased by 4.5% from FY1956 to FY1998. However, the same rate from FY1973 to FY1998 is about 2.3%. The value 1.04 and 1.01 as the rate of $(1+g)/(1+d)$ was used in Nakayama (1997). He did not find the significant difference using both variables.

Equation 4 represents public pension wealth of whose age is $n$ ($n \geq 60$) at time $t$ ($B_{nt}$).

$$B_{nt} = \sum_{i=n}^{100} S_{ni} b_t \left( \frac{1+g}{1+d} \right)^{i-n} \qquad (4)$$

Gross public pension wealth per capita at time $t$ $(SSW_t)$ is given in the following. In equation 5, $m_t$ is the number of public pension participants, $n_t$ is total domestic population and $\varpi_k$ is the ratio of age structure.

$$SSW_t = \lambda \left[ \sum_{k=0}^{59} \varpi_k A_{kt} + \sum_{k=60}^{100} \varpi_k B_{kt} \right], \quad \lambda = \frac{m_t}{n_t} \qquad (5)$$

Expected present value of contribution of public pension participants whose age is 20 to 59 is derived in the following. First, we assume the resource of transfer from national government is tax which nation contributes. The age of a person paying the tax is 20 years to 59 years at time $t$. Thus, the sum of tax and public pension contribution is total contribution of public pension per capita at time $t(c_t)$. Total expected pension contribution of a person who is $a$ years at time $t$ is represented as equation 6.

$$c_{ai} = (1+g)^{i-a} c_t \qquad (6)$$

Total expected present value of public pension contribution of people whose age is $a$ years $(a \geq 20)$ at time $t(TAX_{at})$ is as follows.

$$TAX_{at} = \sum_{i=a}^{59} S_{ai} c_t \left( \frac{1+g}{1+d} \right)^{i-a}, \quad a \geq 20 \qquad (7)$$

From equation 5 and 7, Net wealth of public pension per capita (SSWN) is derived, that is $SSWN_t = SSW_t - TAX_{at}$. Then, using $TAX_{at}$ and $\lambda$ in equation 5, public pension contribution per worker (PREMRP) is derived.

The definitions of the variables used in the empirical analysis are summarized in the following. Small capital s and f in the parenthesis means stock variable and flow variable respectively. The deflator is Consumer Price Index (1995=100).

SSWNRP: Real net wealth of public pension per capita (s)
PREMRP: Real public pension contribution of per worker (f)
CPHRP: Real household consumption per capita (f)
NWHRP: Real net financial wealth of household per capita (s)
SPHRP: Real household savings per capita (s)
YDPRP: Real disposal income per capita (f)
SPH: Nominal household savings (s, total)
FISS: Balance of pension for the aged every fiscal year (f, total)
SSWNT: Nominal net wealth of public pension (s, total)

## 4. Empirical results

From a statistical point of view, it seems that there are some problems with misspecification in the Feldstein (1974)'s type model. In the framework of long run equilibrium relationships, main problem of the extended life-cycle model might be the variable induced from economic theory cannot be added into the regression model; we cannot use lagged disposal income for explanatory variable in the specification[7]. In this section, results of cointegration test based on unit root test, which is taking account of one exogenous structural break in data generating process, are represented firstly. Secondly, the inter-relationships between household savings and pension wealth are analyzed using VECM based on cointegration relationships. Finally, whether public pension is subject to the Ricardian equivalence theorem in Japan is tested by GARCH-M model.

### 4.1. Cointegration test

Based on the results of unit root test considered exogenous one structural break, the cointegration relationship among public pension variable and those related variables, which is disposal income, household savings etc., are tested. The results of unit root tests are presented in Appendix. The Johansen (1988, 1992)'s method is adopted to test

[7] Kumagai (2000, 2001) pointed out the problem that the calculation of inverse matrix cannot be conducted in the cointegration test, if it is used both disposal income in the current period and its lagged variable at the same time. And he showed that the result of the estimation of Feldstein (1974, 1996)'s type model during FY 1955 to 1997 in Japan did not support life cycle hypothesis.

for the cointegration relationship among variables above[8]. The number of cointegration relationship and the problems of whether an intercept and/or trend terms need to be considered can be simultaneously treated in this method. If the null of no cointegration is rejected for the model tested, then the number of cointegration vectors is also determined. As Engle and Granger (1987) showed, in the case of p variables system, the maximum number of cointegration vector is p-1. If the error correcting term estimated satisfies the stationary condition as a result of the test, statistical interpretation of long run equilibrium is given to the term.

The null hypothesis is $H_0 : r \leq k$, the alternative hypothesis is $H_1 : r > k$ , where r and k is the maximum number of cointegration vectors and the number of variables in the system respectively. The results of Johansen test are represented in Table1-1, 1-2 and 1-3. One or two asterisk in the table means 5% or 1% criterion.

As a result of cointegration test, one cointegration relationship was found to all the combination tested. The variables which combination constitutes are as the following, respectively: [1] SPHRP, SSWNRP, YDPRP and NWHRP, [2] SPHRP, PREMRP, YDPRP and NWHRP, [3] SPH, FISS and SSWNT.

Table1-1. The result of Cointegration test

Variables: SSWNRP・SPHRP・YDPRP・NWHRP (lag1, no deterministic trend, FY 1957-1997)

| Eigenvalue | Likelihood ratio | Critical Value (5%) | Critical Value (1%) | Number of Cointegration |
|---|---|---|---|---|
| 0.597 | 67.28 | 53.12 | 60.16 | None ** |
| 0.362 | 29.92 | 34.91 | 41.07 | 1 at most |

8) Morandé (1998) analyzed the crowding out on private savings arising from social security reform in Chile. In his work, Engle-Granger method was applied to test for the cointegration relationship among 6 or 7 variables. However, by this method, the number of cointegration relationship among 3 variables and over cannot be derived precisely. Therefore, it seems that Morandé (1998)'s approach is not adequate statistically.

Table 1-2. The result of Cointegration test

Variables: PREMRP・SPHRP・YDPRP・NWHRP (lag1, deterministic trend, FY 1957-1997)

| Eigenvalue | Likelihood ratio | Critical Value (5%) | Critical Value (1%) | Number of Cointegration |
|---|---|---|---|---|
| 0.463 | 50.89 | 47.21 | 54.46 | None * |
| 0.335 | 25.36 | 29.68 | 35.65 | 1 at most |

Table 1-3. The result of Cointegration test

Variables: SPH・FISS・SSWNT (lag1, no deterministic trend, FY 1973-1997)

| Eigenvalue | Likelihood ratio | Critical Value (5%) | Critical Value (1%) | Number of Cointegration |
|---|---|---|---|---|
| 0.772 | 50.90 | 34.91 | 41.07 | None ** |
| 0.318 | 13.87 | 19.96 | 24.60 | 1 at most |

### 4.2. Inter-relationships between household savings and pension wealth by VECM

Maximum likelihood estimation of Vector Error Correction Model (VECM) based on the results of cointegration test is carried out. Two combinations of the variables, saving functions we concern, are accepted statistically. Those are showed in Table 2-1. T-values are given in the parenthesis and the explanatory variable $\Delta X$ means the first difference series of the variable X in the table. The coefficient of the error correcting term represents the speed of the adjustment in the long-run equilibrium relationship. The error correcting term of models are represented in Table2-2. The term is both statistically significant in 5% level and satisfied the stationary condition; thus interpretation of long-run equilibrium is given to the term of each saving function[9].

[9] In the case of no long-run equilibrium relationship in the model, Komamura et al. (2000) pointed out the problem of the stability of the parameter estimated. Because there is a long-run equilibrium relationship in models, the results of the estimation in the current paper are not influenced a great deal by changing sample period.

Table 2-1. Saving Function
Dependent variable: ΔSPHRP, FY1957-1997
Model 1; the model for SPHRP, SSWNRP, YDPRP and NWHRP
Model 2; the model for SPHRP, PREMRP, YDPRP and NWHRP

| Explanatory variable | Model 1 | Model 2 |
|---|---|---|
| Error correcting Term | -0.331(-2.26) | -0.221(-2.62) |
| ΔSPHRP | 0.318(1.60) | 0.097(0.56) |
| ΔYDPRP | 0.139(1.61) | 0.107(0.56) |
| ΔSSWNRP/ ΔPREMRP | 0.007(1.02) | 0.111(0.33) |
| ΔNWHRP | -0.028(-1.91) | -0.036(-2.67) |
| Constant | --- | 0.457(0.56) |
| AIC, SBC | 27.94, 28.99 | 20.19, 21.36 |

Constant term is not included in the specification of Model 1. All explanatory variables except constant term are one time period lagged values. To determine the lag length, both AIC and SBC are used. AIC and SBC is Akaike Information Criterion and Schwarz Bayesian Criterion respectively.

The result of Model 1 is used in the following analysis since the variable NWHRP in the error correcting term of Model 2 is rejected in 10% significant level. The variable NWHRP includes the inflation effect of wealth to consumption.

Table 2-2. Error correcting Term
Dependent variable: SPHRP, FY1957-1997
Model 1; the model for SPHRP, SSWNRP, YDPRP and NWHRP
Model 2; the model for SPHRP, PREMRP, YDPRP and NWHRP

| Explanatory variable | Model 1 | Model 2 |
|---|---|---|
| YDPRP | 0.4236(23.85) | 0.3550(12.72) |
| SSWNRP/ PREMRP | -0.0617(-7.76) | -1.8406(-3.44) |
| NWHRP | -0.0220(-3.27) | 0.0431(1.31) |
| Constant | 10.6266(8.55) | -11.0812 |

All explanatory variables are current time period values.
Constant term is anonymous in the specification of Model 2.

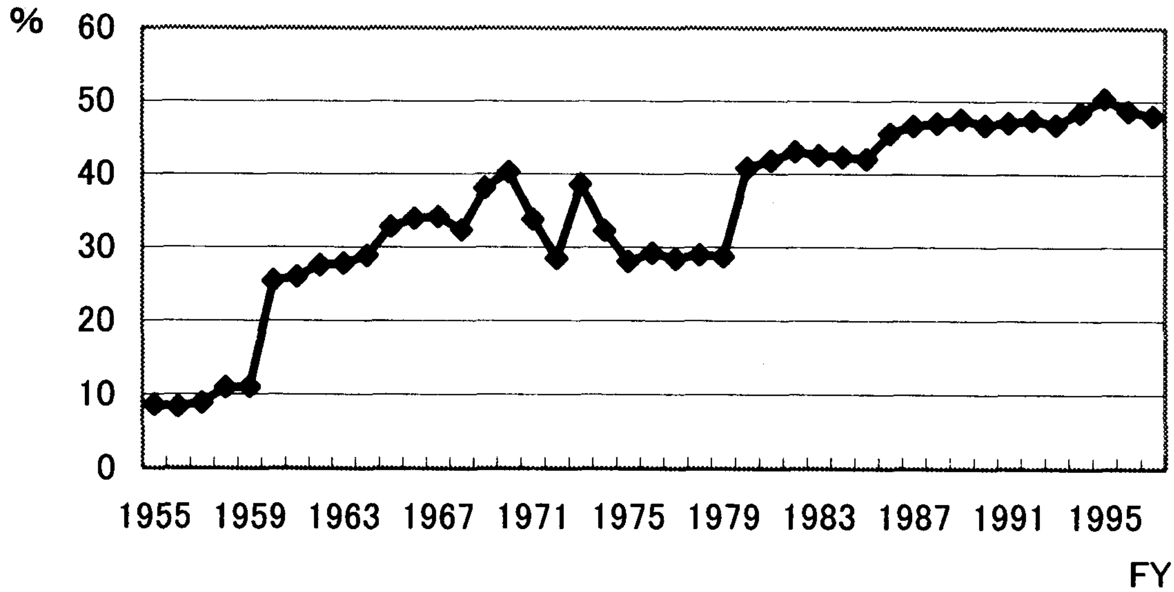
The coefficient of SSWNRP in the error correcting term is negative and significant statistically; thus it can be considered that an increasing public pension wealth have reduced household savings in the long term[10]. Then, the interpretation that the wealth replacement effect is larger than the induced retirement effect is given to Japan's public pension system.

The ratio of substantial reduction of household savings to real value SPHRP, $\gamma$, is calculated as equation 8. The ratio is showed in Figure 1.

$$\gamma = \frac{0.0617 SSWNRP}{SPHRP} \qquad (8)$$

The mean of $\gamma$ in FY1955-1973 and FY1974-1997 is 26.06 and 41.58 respectively. Then, the magnitude of substantial reduction of household savings in the latter period is about 1.6 times than that in the former period.

Figure 1. The ratio of substantial reduction of household savings




To obtain an order of magnitude for the substantial reduction in the capital stock, we use a Cobb-Douglas production function. The function of which there is the long-run equilibrium relationship in the error correcting term is represented as equation 9.

[10] It cannot be determined whether the wealth effect of SSWNRP and NWHRP is large since the ratio of both variables is fluctuated a great deal in the sample period.
A substantial effect on the distribution of wealth may have been large.

Factor shares would be unchanged in the error correcting term. The definition of variables and statistics is given in the footnote 11. The change of production per capita in the long run is captured by dummy variable $(\tau)$ [11]. The estimation is by maximum-likelihood method and it assumed first moving average in the error term.

$$\Delta \ln\left(\frac{Y}{LH}\right) = -0.0053\left[\ln\left(\frac{Y}{LH}\right) - 0.4362\ln\left(\frac{KS}{LH}\right) + 4.0451\right]_{-1}$$

$$(-6.46) \qquad (-3.52) \qquad (13.80)$$

$$+0.6054\,\Delta \ln\left(\frac{Y}{LH}\right)_{-1} + 0.0159\tau + \varepsilon_t$$

$$(9.98) \qquad (3.71) \qquad\qquad (9)$$

$$\varepsilon_t = u_t - 0.5989u_{t-1}$$

$$(-3.92)$$

$$\text{D.W.} = 2.06 \quad \text{S.E.} = 0.012$$

As the result of the estimation, it can be conjectured that the progressing rate of Cobb-Douglas technology in the long term is 1.75%, which is calculated as $e^{-4.0451}$ =0.0175.

The distribution rate of capital in the long term is 0.4362, as is presented in the error correcting term in equation 9. Using the rate and the mean of $\gamma$ in FY1974-1997, 41.58, the substantial reduction rate of the growth rate of real GDP per capita in FY1974-1997 is calculated as $(1+0.4158)^{0.4362}-1 \cong 0.1637$. It can be considered that enlarged public pension system have reduced the growth rate of real GDP per capita by16% in the duration. Then, substantial reduced growth every year is by 0.416%point

[11] For a more detail review about exogenous variable in the framework of VECM, see Ch.4 and Ch.6 in Davidson (2000).

The variables used are as follows: Y is real GDP, KS is operated stock which is the product of operation rate multiplied by capital stock, LH is operated labor force which is the product of the number of workers multiplied by hours of labor, $\tau$ is constant dummy variable ( $\tau$=1 in FY1966-1970, 0 otherwise).

The statistics D.W. and S.E. is the ratio of Durbin-Watson and standard error of regression, respectively. Adjusted R-squared is 0.811, which is a reference criterion in the maximum likelihood estimation.

since the average rate of the growth rate of real GDP per capita is about 2.60%.

### 4.3. Investigation of the Ricardian equivalence theorem

In this section, firstly, the specification of econometric model for the test of the Ricardian equivalence theorem is introduced. Whether public pension is subject to the Ricardian equivalence theorem in Japan is tested by GARCH-M model, which can capture the risk premium of the annuity. Secondly, in the context of measuring the variation of public pension wealth and household savings, an economic interpretation of the conditional second moment is given.

The ARCH models are designed to model and forecast the conditional variance. The GARCH in Mean model or GARCH-M model is a generalized ARCH -M model that is an extension of the ARCH model and is developed by Engle et al. (1987).

In the ARCH-M model, the heteroscedasticity is specified as GARCH (p, q) and then the conditional variance is added or some function of it to the specification of the mean equation. The variance today depends upon three factors: a constant, past news about volatility as is to be squared residual from the past and past forecast variance. In the case that the conditional standard deviation is included in the regression function, the model for the conditional mean $(y_t)$ and the conditional variance $(h_t)$ is specified as follows:

Mean equation: $y_t = x_t\beta + \lambda\sigma_t + \varepsilon_t\ ,\quad \sigma_t = \sqrt{h_t}$

Variance equation: $h_t = \alpha_0 + \sum_{i=1}^{p}\alpha_1\varepsilon_{t-1}^2 + \sum_{i=1}^{q}\beta_1 h_{t-1}$

where $\varepsilon_t = u_t\sqrt{h_t}, u_t \sim i.i.d.N(0,1)$

In Engle et al. (1987), the excess return on holding a long bond relative to a short bond is modeled as a function of the log of the conditional standard deviation of the innovations in the regression model. The interpretation of this variable is as a measure of the time varying risk premium. Following them, it can be measuring uncertainty of the pension for the aged based on the conditional variance of the innovations modeled by GARCH-M.

To test the Ricardian equivalence theorem regarding public pension following

Meguire (1998), a regression model as equation 10 is estimated.

$$\Delta SPH = \alpha^{*}SSWNT + \beta^{*}FISS + \gamma^{*}FISS_{-1} \qquad (10)$$

The dependent variable is the first difference series of household savings. In the case $\beta^{*}=1$, an economic interpretation that a complete substitute relation between household savings and pension for the aged is given. On the contrary, in the case $0 < \beta^{*} < 1$, it can be considered there is a partial substitute relation between them.

The result of the GARCH (1,1)-M model is represented in equation 11. The conditional mean part and conditional variance part are specified as follows, respectively:

$$\begin{aligned} \Delta SPH = & -0.0035(SSWNT - 161.7133FISS + 122749.3) \\ & \quad (-7.62) \qquad\qquad (-13.58) \\ & + 0.5617\sigma_t + 5757.62DUM74 + \varepsilon_t \\ & \quad (6.22) \qquad\qquad (6.88) \\ h_t = & \ 213806.6 + 0.0353\varepsilon_{t-1}^{2} + 0.8869h_{t-1} \\ & \quad (1.76) \qquad (15.40) \qquad (108.98) \end{aligned} \qquad (11)$$

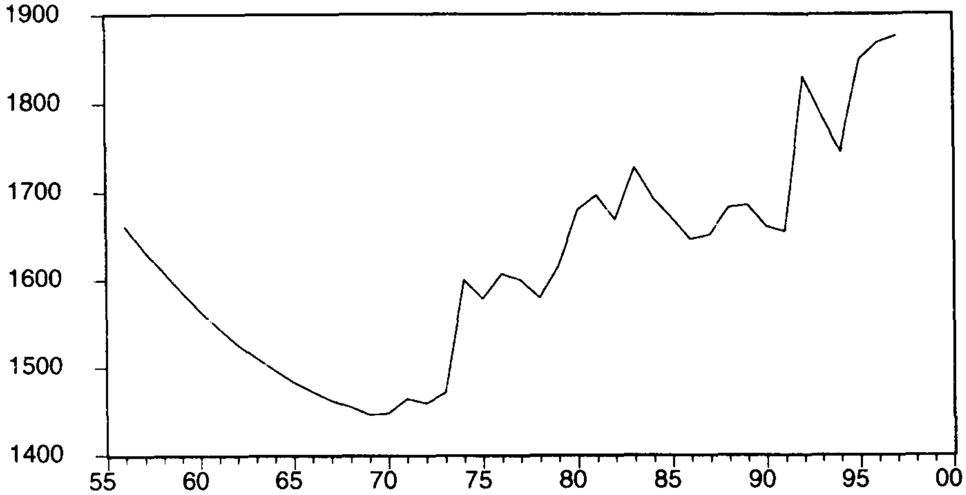
D.W.=1.93 S.E.=1810.07 AIC= 17.93 SBC=18.17

Though the lagged variable of FISS is not significant, both the ARCH term and the GARCH term are significant in the variance equation. The relation between household savings and pension for the aged is a partial substitute since $0 < \beta^{*} < 1$ . Then, public pension is not subject to the Ricardian equivalence theorem in Japan.

It is noted that the coefficient $\lambda$ of the explanatory variable $\sigma_t$, conditional standard deviation of public pension, in the mean equation is beyond 0.5. Because the value means the extent of the risk aversion, it can be considered that the estimate of $\lambda$ implies that the household has been increasing savings to avert risk of their pension benefits.

On the other hand, the variable $\sigma_t$ is represented in Figure 2. It had declined during some years since 1961, when National Health Insurance System started. In the duration, public pension system is almost operated by funded system. Therefore, the character of public pension is considered as the same as private savings.

Figure 2. Conditional standard deviation of public pension ($\sigma_t$)




There is a sudden change of the variable $\sigma_t$ in FY1974, when just after pension system had removed to unfounded system. The magnitude of it had been growing under unfounded system. It is noted that the fluctuation of it in large scale recently; thus we might consider that the reliability for public pension scheme has been deteriorating. Through the test of the Ricardian equivalence theorem regarding public pension in Japan, we can conclude that the existence of public pension system prevents accumulating savings whole nation in the short run.

**5. Conclusion**

This paper investigates the magnitude of the adverse impact of public pension on household savings and tests whether public pension is subject to the Ricardian equivalence theorem in Japan. Using time series data, aggregated variables both net wealth of public pension for the aged and the annuity payment of working generation are defined. We reconsidered conventional framework for econometric modeling the inter-relationships between household savings and pension wealth by VECM based on the cointegration relation and GARCH-M model. The GARCH-M can capture the risk premium of the annuity.

Main results of this study are summarized in the following. First, public pension wealth has depressed household savings by almost 50 percent recently. It implements a substantial reduction in GDP; the growth rate of real GDP per capita was 0.4% point lower than the observed value during FY1974-1997. Second, through the test of the Ricardian equivalence theorem using GARCH-M model, two evidences were found. One is partial substitute relation between household savings and pension wealth. The other is the fact that conditional standard deviation of pension for the aged has been growing recently. From the latter finding, we might consider that the reliability for public pension scheme has been deteriorating.

**Appendix**

Unit Root Tests

To perform the standard statistical inferences on the regression analysis in which non-stationary time series data are used, the data generating processes of the variables concerned are analyzed by the unit root tests in which a special attention must be paid to the existence of a trend and the structural breaks.

Kumagai (2000), for instance, pointed out that it is important to take the existence of the structural break of the Japanese social security system in FY1973 into consideration. Therefore, based on Perron (1989, 1994)'s procedure, a series of unit root tests of the variables in the following were conducted. The structural break of the Japanese social security system in FY 1973 is exogenously given. In the year, both contribution of public pension participants and benefit per beneficiaries were greatly raised.

The variables tested are SSWNRP, PREMRP, CPHRP, NWHRP, SPHRP, YDPRP, SPH, FISS and SSWNT. Sample duration of the test is from FY1956 to FY1997. As the results of unit root tests, those are all I (1) variable. Specifications of Perron's procedure applied in the current paper and a more detail of the results of the unit root tests are presented in Kumagai (2001).

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