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The Social Security System and the Demand for Personal Annuity and Life Insurance
An Analysis of Japanese Microdata, 1990 and 1994

Seki Asano

3.1 Introduction

The two most important objectives of the social security system are to support workers in their retirement and, in the case of unexpected death (or disability) of the breadwinner, to provide a stable financial base for the surviving family members. The current social security system offers partial insurance for these risks, but by no means provides customized protection for individual households. Individual workers must prepare for the risk of living beyond retirement, and for the risk of unexpected death. They prepare for these risks by allocating their wealth to various assets.

For example, households can adjust their future asset positions by purchasing two types of insurance. Those who want more protection against living for many years in retirement than the public pension system offers would purchase a private annuity. Those who want protection for family members in the event of the breadwinner's death soon after retirement would purchase life insurance. The resulting asset allocation would reveal the relative strengths of these two motives.

This study examines the effects of public pension benefits on Japanese households' choice of life insurance versus private annuity. Two waves of microdata, constituting the Nikkei Radar Survey (RADAR) and obtained in 1990 and 1994, provide a unique opportunity to observe the effects of changes in social security benefits, total asset values, and expectations on households' asset allocations.

In 1994, at the time of the second-wave survey, the Japanese Diet passed the Social Security Reform Bill. Its main change from the previous 1985

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system was to shift the starting age of basic pension provision from sixty to sixty-five. This reform affected males under age fifty-two (in 1994), whose benefits were delayed by one to five years. One focus of this study is to ask how households reacted to this reform.

Also important to this study are the sharp decline in stock prices and the falling real estate values that began in early 1990. The average market value of households' total assets fell about 40 percent by 1994, according to the sample shown later in table 3.1. In addition, the Japanese economy was then in a deep recession; thus the public's prospects for the future became less optimistic. I look at three age groups—people in their thirties, forties, and fifties—to see how households react to these changing economic conditions in various stages of their life cycles.

In the past, empirical studies of the effect of public pensions on life insurance and private annuity purchase yielded varied results. Bernheim (1991) examined the life insurance and personal annuity holdings of retirees and concluded that pension benefits had a significant positive effect on life insurance holdings but depressed personal annuities. Hence, a substantial portion of saving is motivated by bequests. In his analysis, however, life insurance was measured at total face value, not net of saving. Using the same data set, Hurd (1989) examined the wealth and consumption trajectory of retirees and concluded that the bequest motive is weak. Iwamoto and Furuie (1995, 1996) examined the 1990 RADAR data and found a weak effect of bequestable assets on the demand for life insurance. In a somewhat different approach, Chuma (1994) estimated the effect of the intended bequest motive on the demand for life insurance from the same 1990 RADAR data. He found that there was a significant effect for the younger age group, but not for the older group.

This study differs from previous studies in the following aspects: it looks at a sample of household heads of working age (thirty to fifty-nine); it isolates savings in life insurance and personal annuities from gross savings; and it analyzes two data sets from periods when drastic changes in the social security system and the Japanese economy were taking place.

In this analysis, I consider market assets (the sum of monetary and real assets), annuities, and life insurance. Life after retirement is supported by accumulated market assets and annuities. On the other hand, in the case of the breadwinner's death, market assets and life insurance payments will be bequeathed to the surviving family members.

Annuities consist of both public pensions and personal annuities, and life insurance consists of both public and private life insurance. In the case of the insured's death, the social security system becomes a form of life insurance. Although it is compulsory to join social security, the level of benefits provided by the system may not be the same as the individual's desired amount: Desired levels of annuities and life insurance vary from person to person depending on values, education, life stage, family composition, social status, and other factors. Hence, the observed pattern of holding (private) life insurance and personal annuities can be interpreted as the result of adjusting the gap between the desired level and the compulsory provided benefits of the social security system. Also, because negative holdings of life insurance and private annuities are practically impossible, public pensions provide a lower limit for individual annuities and life insurance.

If a person has a strong bequest motive, any increase in pension benefits will be countered by an increase in life insurance. The other side of this adjustment is a reduction in personal annuities or market assets. If the person has no bequest motive, increased pension benefits result in a reduction of personal annuities, leaving the level of life insurance constant.

However, identifying the relative importance of these various motives is a difficult task. Since social security pension benefits are closely tied to public life insurance coverage, an increase in the former also brings about an increase in the latter. Private life insurance both provides bequests to the surviving family (pure bequest), and saving for the insured person. Most life insurance contracts in Japan serve these two functions, and thus a substantial portion of them should be regarded as saving (market assets).

My data sets contain unique information enabling the calculation of the amount of pure life insurance, annuity, and saving (market assets) for both public and personal insurance/annuity, under plausible assumptions. Using data on these assets, I estimate a model in which individuals choose personal annuity and life insurance in order to maximize utility.

The next section presents a theoretical model and an econometric specification of binding nonnegative choice. Section 3.3 describes the data sets, and explains some of the variables. Section 3.4 discusses estimation results. Section 3.5 concludes the paper. The appendix gives a brief description of the Japanese social security system and of other variables in the paper.

3.2 The Model and Econometric Specification

3.2.1 The Model

This model may lead to four types of private annuity and life insurance holding patterns, based on rational choice of a household:

$$\text{(private annuity, life insurance)} = (+,+), (+,0), (0,+), \text{and } (0,0).$$

I assume that the utility of the household depends on marketable wealth (M), which is the sum of marketable monetary and real wealth including demand deposits, stocks, bonds, real estate, etc., annuity (A), which is the annuity and pension received after retirement; and life insurance (L), which is life insurance to be received by the surviving family if the holder dies. A natural formulation of the choice of these three assets may be the following expected utility function:

$$U(M,A,L) = PU_L(M + A) + (1 - P)U_B(M + L),$$

where P is the individual's probability of survival to retirement age. U_L is individual utility when one lives to retirement age and holds market assets, M, and annuities, A. U_B is the utility from bequests when the individual dies before retirement, with the surviving family receiving M and L. This is the model adopted by Bernheim (1991). However, this formulation leads to the prediction that nobody holds a personal annuity and life insurance at the same time. Obviously, that prediction is violated by the data.

In order to avoid such a deficiency, I assume that the functional form is of the linear expenditure system type, written as

$$(1) \qquad U = \alpha_M \ln(M - M_0) + \alpha_A \ln(A - A_0) + \alpha_L \ln(L - L_0).$$

Marketable wealth (monetary and real assets), M, includes all the financial and real assets that can be bought and sold in the markets. The parameters, M_0, A_0, and L_0, may be interpreted as the minimum level of the three assets, but such strict interpretation is not necessary. We can assume that $\alpha_M + \alpha_A + \alpha_L = 1$.

Annuity consists of two components, the first provided by the government in the form of social security pension benefits, and the second a personal annuity purchased by the householder. Thus A is written as

$$(2) \qquad A = A_P + A_G,$$

where A_P indicates private annuity and A_G indicates public pension.

Life insurance is the conditional payment to the surviving family members when the head of household dies. In this sense, the social security system plays the role of public life insurance. If the recipient of a social security pension dies, the surviving family members will receive some part of pension payments for a certain period. Hence, total life insurance is the sum of private and public life insurance.

$$(3) \qquad L = L_P + L_G,$$

where L_P indicates private life insurance and L_G indicates public life insurance.

The householder will allocate total private wealth to three assets, M, A_P, and L_P, under the wealth constraint.

$$(4) \qquad W = M + aA_P + lL_P,$$

where a and l are prices of A_P and L_P, respectively.

Since it is not possible to hold a negative personal annuity (A_P) and life insurance (L_P), the first-order conditions are the Kuhn-Tucker conditions shown in equations (5), (6), and (7).

$$\text{(5)} \qquad M\colon \frac{\alpha_M}{M - M_0} - \lambda \leq 0 \leq M,$$

$$\text{(6)} \qquad A_P\colon \frac{\alpha_A}{A_P + A_G - A_0} - a\lambda \leq 0 \leq A_P, \text{ and}$$

$$\text{(7)} \qquad L_P\colon \frac{\alpha_L}{L_P + L_G - L_0} - l\lambda \leq 0 \leq L_P,$$

where double inequalities ($\leq 0 \leq$) imply that if the inequality holds on the left, equality holds on the right, and vice versa. Although it is possible to have negative M, I assume that all households have positive M, i.e., that equation (5) holds with equality on the left. Thus,

$$\text{(8)} \qquad \lambda = \frac{\alpha_M}{M - M_0}.$$

Substituting equation (8) into equations (6) and (7) yields

$$\text{(9)} \qquad A_P\colon \frac{\alpha_A}{A_P + L_G - L_0} - \frac{a\alpha_M}{M - M_0} \leq 0 \leq A_P, \text{ and}$$

$$\text{(10)} \qquad L_P\colon \frac{\alpha_L}{L_P + L_G - L_0} - \frac{l\alpha_M}{M - M_0} \leq 0 \leq L_P.$$

An alternative representation of equations (9) and (10) is obtained by replacing (M by $M = W - aA_P - lL_P$), where W is the total wealth.

$$\text{(11)} \quad A_P\colon \frac{\alpha_A}{A_P + A_G - A_0} - \frac{a\alpha_M}{W - aA_P - lL_P - M_0} \leq 0 \leq A_P$$

$$\text{(12)} \quad L_P\colon \frac{\alpha_L}{L_P + L_G - L_0} - \frac{l\alpha_M}{W - aA_P - lL_P - M_0} \leq 0 \leq L_P$$

3.2.2 Econometric Specification

Solving equations (11) and (12) for A_P and L_P, respectively, and adding disturbance terms u_A and u_L, the structural form of the personal annuity and private life insurance demand functions is

$$\text{(13)} \qquad A_P = \left(\frac{l}{a}\right)\left(\frac{\alpha_A}{\alpha_M + \alpha_A}\right)L_P + \left(\frac{\alpha_M}{\alpha_M + \alpha_A}\right)(A_0 - A_G) + \left(\frac{\alpha_A}{\alpha_M + \alpha_A}\right)\frac{W - M_0}{a + u_A}, \text{ and}$$

$$\text{(14)} \qquad L_P = \left(\frac{a}{l}\right)\left(\frac{\alpha_L}{\alpha_M + \alpha_L}\right)A_P + \left(\frac{\alpha_M}{\alpha_M + \alpha_L}\right)(L_0 - L_G) + \left(\frac{\alpha_L}{\alpha_M + \alpha_L}\right)\frac{W - M_0}{l + u_L}.$$

The right-hand side of equations (13) and (14) are the latent demand for A_P and L_P, but the observed demands for A_P and L_P are nonnegative. When the RHS of equation (13) is negative, $A_P = 0$, the same relationship holds for equation (14) and L_P.

I assume that the joint distribution of (u_A, u_L) is independently and identically distributed (i.i.d.) bivariate normal.

$$\text{(15)} \qquad \begin{bmatrix} u_A \\ u_L \end{bmatrix} \sim N\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{bmatrix} \sigma_{AA} & \sigma_{AL} \\ \sigma_{LA} & \sigma_{LL} \end{bmatrix}\right\} = N(0, \Sigma_u)$$

The system in equations (13), (14), and (15) is a bivariate simultaneous Tobit model for which both A_P and L_P take nonnegative values ($A_P \geq 0$, $L_P \geq 0$).

In estimating the model, I have reliable data on L_P, L_G, A_P, and A_G, but W is not observable and A_0, L_0, and M_0 are unknown parameters. Assuming that W, A_0, L_0, and M_0 are linear functions of the observables, the estimable form of the structural equation is

$$\text{(16)} \qquad A_P = \gamma_L L_P + \mathbf{x}'\beta_A + u_A, \text{ and}$$

$$\text{(17)} \qquad L_P = \gamma_A A_P + \mathbf{x}'\beta_L + u_L,$$

where, $\mathbf{x}'$ is the vector that consists of observed exogenous variables.

I divide the observations into four groups, denoted by I, II, III, and IV.

$$\text{I.: } A_P > 0, \quad L_P > 0$$

$$\text{II.: } A_P > 0, \quad L_P = 0$$

$$\text{III.: } A_P = 0, \quad L_P > 0$$

$$\text{IV.: } A_P = 0, \quad L_P = 0$$

Then, the likelihood function is given by the following:

$$(18)\quad L = \Pi_{i\in \mathrm{I}}(1 - \gamma_L\gamma_A)f(A_{Pi} - \gamma_L L_{Pi} - \mathbf{x}_i'\beta_A, L_{Pi} - \gamma_A A_{Pi} - \mathbf{x}_i'\beta_L)$$

$$\Pi_{i\in \mathrm{II}}\int_{-\infty}^{-\gamma_A A_{Pi} - \mathbf{x}_i'\beta_L} f(A_{Pi} - \mathbf{x}_i'\beta_A, u_L')du_L,$$

$$\Pi_{i\in \mathrm{III}}\int_{-\infty}^{-\gamma_L L_{Pi} - \mathbf{x}_i'\beta_A} f(u_A, L_{Pi} - \mathbf{x}_i'\beta_A)du, \text{ and}$$

$$\Pi_{i\in \mathrm{IV}}\int_{-\infty}^{-\mathbf{x}_i\beta_A}\int_{-\infty}^{-\mathbf{x}_i'\beta_L} f(u_L, u_A)du_L du_A,$$

where $f(\cdot)$ is a bivariate normal density function with zero means and the variance matrix Σ_u. The maximum likelihood estimates of (γ_A, γ_L, β_A, β_L, Σ_u) can be obtained by maximizing equation (18).

3.3 Data

3.3.1 Nikkei Radar Survey

As mentioned earlier, the data sets used in this study are taken from the two waves (1990 and 1994) of an annual survey conducted by the Data Bank Bureau of Nihon Keizai Shimbun, called the Nikkei Radar Survey (RADAR). In RADAR, about 5,000 individuals aged twenty-five to sixty-nine were interviewed each year. The observations were collected from the Tokyo area (metropolitan Tokyo, Saitama, Chiba, and Kanagawa prefectures, excluding offshore islands). The response rates were 56.4 percent (2,818) in 1990 and 54.4 percent (2,721) in 1994. The survey asked detailed questions about household income: financial asset holding patterns, including life insurance and private annuities, and various monetary and real assets. The survey also collected information on each household's family background, ages, education, family composition, life stage, and work status of husband and wife.

For the econometric analysis, I limited observations to the families of married couples whose husbands are between the ages of thirty and fifty-nine and work full time as wage earners. After observations with missing values or improbable figures were removed, the sample size was 789 in 1990 and 610 in 1994.

3.3.2 Definition of Variables

The following variables were used in the model.

Variable Name	Description	Unit
H_AGE	Age of husband	year
ERN_P	Annual permanent earnings of household	million yen
RASST	Real asset	million yen
D_OWN_H	Owns home	dummy (0,1)
TFASST	Total financial asset	million yen
A_P	Private annuity	million yen

Variable Name	Description	Unit
L_P	Private life insurance	million yen
A_G	Public pension	million yen
L_G	Public life insurance	million yen
NDEPKID	Number of dependent children	person
H_CLLG	Husband graduated college	dummy (0,1)
H_LARG	Husband works in large firm (500+ employees)	dummy (0,1)
H_PUBS	Husband works in public sector	dummy (0,1)
W_EMPF	Wife works full time	dummy (0,1)

Public pension (A_G) is the sum of public pension benefits beginning at age sixty discounted by mortality risk. Mortality risk comes from the 1990 Japanese Population Census, and the discount rate is set at 5 percent. I also assume that the individual will retire at age sixty.

The life insurance component of public pension (L_G) is defined as the expected receipt of a survivor's pension benefit conditional on the head of household's being alive at the time of the survey. I then consider death at age H_AGE+1, H_AGE+2, . . . up to age eighty (see appendix).

Of course, the value of L_G is related closely to the public pension benefit (A_G), because the Employees' Pension Insurance Survivors' Benefit (EPISB) is three fourths of the public pension benefit. The total value of L_G is the sum of EPISB and additional benefits that depend on family composition and wife's age and work status.

(Private) life insurance (L_P) is the expected sum of life insurance coverage from private sources.

Net life insurance is the discounted sum of expected life insurance receipts from life insurance and personal annuities, conditional on the person's being alive at age H_AGE, minus any cancellation value of insurance contracts (see appendix).

The value of private annuity (A_P) is defined as the expected value of a discounted sum of private annuity flow beginning at age sixty. As in the case of public pension, A_P is discounted by mortality risk.

Total financial assets (TFASST) is defined as the sum of the usual financial assets (such as demand deposits, time deposits, bonds, stocks, money in trust, and other monetary assets) and the cancellation value of life insurance and private annuities, minus the present value of home loan payments. I classify single-payment old age life insurance (*ichiji harai yoro hoken*) as a financial asset instead of life insurance, because it usually has a short maturity period (five years) and mostly is purchased as a short-term saving asset. For this reason I do not include it in the calculation of life insurance payments to survivors. Its financial value is set as the amount of reimbursement at maturity. Also, variable life insurance (*hengaku hoken*) is usually purchased as a financial asset. Half of its guaranteed minimum life insurance coverage is included in TFASST.

RASST is the sum of the market value of land, condominiums, and other assets including gold, coins, membership in golf clubs, and the like.

In RADAR, the response to the questions relating to real assets may contain serious errors. The questionnaire first asks the value of "own land" where the owner resides, then asks the value of "other" land and real estate, including condominiums. With this setup, some owners of owner-occupied condominiums may answer "zero" to both questions, in which case the value of the RASST is zero even though the respondent owns real estate. In fact, about 200 homeowners responded in this manner in both waves. Though I excluded these observations from the sample, other errors may be contained in this variable. For example, homeowners may report the value of the land excluding the value of the house. For this reason I display RASST and TFASST separately in the list of explanatory variables.

3.3.3 Descriptive Statistics

Table 3.1 shows the mean values of the variables by age group for 1990 and 1994. As shown, the decline in the real estate market and the stock market lowered the value of land to about 50 percent of its 1990 level, and lowered the value of high-risk financial assets. Total market assets declined to about 50 percent of their 1990 level for those in their thirties, 66 percent of their 1990 level for those in their forties, and about 60 percent of the 1990 level for those in their fifties.

The effect of changes in the social security system for household portfolios is apparent in the shift in personal annuities. The proportion of A_P holders increased across all age groups: from 19 percent to 33 percent for those in their thirties, 23 percent to 34 percent for those in their forties, and 29 percent to 40 percent for those in their fifties. The mean value of A_P, however, appears to have stayed about the same.

On the other hand, the proportion of life insurance holders declined by anywhere from 6 percent to 10 percent across all age groups. Gross life insurance coverage stayed about the same, but saving from life insurance fell by 2 million yen (for those in their fifties) and by 0.4 million yen (for those in their forties). Also, although it is not indicated in the table, all the annuity holders held life insurance in both waves.

Public pension benefits (A_G) declined a little for those in their thirties and forties but stayed the same for those in their fifties. Public life insurance (L_G) increased about 10 percent. Thus, in my sample social security reform, life insurance increased slightly and pension benefit declined.

3.4 Results

3.4.1 Structural Form Estimates

I estimate the structural form of the model using the maximum likelihood method for individuals in their thirties, forties, and fifties. I use L_G as an instrument for L_P in the A_P equation, and A_G for A_P in the L_P equation. The results are shown in table 3.2.

Table 3.1 Descriptive Statistics by Age

		Ages 30–39		Ages 40–49		Ages 50–59		All	
		1990	1994	1990	1994	1990	1994	1990	1994
Permanent earnings (million yen)	ERN_P	6.02	6.76	7.95	8.97	9.18	9.44	7.61	8.41
Total monetary asset[a] (million yen)		6.36	5.14	10.04	9.75	16.28	12.61	10.42	9.18
Real asset, land (million yen)		21.55	6.06	40.82	21.61	65.21	37.78	40.61	21.73
Total real asset (million yen)	RASST	26.08	10.23	48.97	30.06	79.64	45.68	49.16	28.64
Proportion of home owners (%)	D_OWN_H	44	33	78	63	84	80	68	59
Total net financial asset[b] (million yen)	TFASST	5.22	4.16	9.79	6.83	20.06	14.57	10.93	8.41
Total market asset[c] (million yen)		31.3	14.38	58.75	36.88	99.71	60.25	60.09	37.04
Personal annuity	A_P	1.21	1.55	1.06	1.39	1.25	1.97	11.16	1.62
Saving from personal annuity (million yen)		0.04	0.03	0.31	0.31	1.23	1.71	0.46	0.66
Proportion of personal annuity holders (%)		19	33	23	34	29	40	23	36

Life insurance, gross (million yen)		29.21	29.39	30.67	29.73	23.58	22.87	28.27	27.48
Life insurance, net (million yen)	L_P	26.03	27.13	24.96	24.42	15.93	17.16	22.93	23.01
Saving from life insurance (million yen)		3.18	2.26	5.71	5.31	7.65	5.72	5.35	4.47
Proportion of life insurance holders (%)		82	73	87	80	84	79	85	77
Public pension (million yen)	A_G	19.71	19.19	19.86	18.79	21.54	22.56	20.26	20.11
Public life insurance (million yen)	L_G	7.63	8.59	9.94	10.76	11.09	11.93	9.44	10.44
Dependent children	NDEPKID	1.52	1.53	1.96	1.78	1.02	0.98	1.56	1.45
College degree (%)	H_CLLG	59	57	45	49	42	41	49	49
Public sector (%)	H_PUBS	15	12	10	16	13	15	12	15
Large firm (%)	H_LARG	44	41	40	45	43	41	42	42
Wife employed full time (%)	W_EMPF	13	14	18	20	20	12	17	16
Sample size		275	194	304	225	210	191	789	610

[a]Sum of demand deposit, time deposit, stocks, bonds, bank debenture, foreign currency saving, and other monetary assets.

[b]Sum of total monetary asset, and cancellation value of personal annuity and life insurance, minus present value of home loan.

[c]RASST + TFASST.

Table 3.2 **Structural Form Estimate**

Variable	1990 Estimate	1990 Structural Estimate	1990 *t*-ratio	1994 Estimate	1994 Structural Estimate	1994 *t*-ratio
		Dependent A_P (ages 30–39)				
L_P	0.10	0.10	0.97	0.13	0.04	3.12
CONST	−3.17	22.24	−0.14	−25.35	16.56	−1.53
A_G	−2.03	0.98	−2.08	0.44	0.63	0.69
TFASST	−0.05	0.14	−0.37	0.09	0.11	0.80
RASST	0.01	0.02	0.41	−0.05	0.04	−1.24
D_OWN_H	3.49	3.06	1.14	−0.63	2.12	−0.30
ERN_P	3.67	1.83	2.01	−0.66	1.31	−0.51
NDEPKID	−1.07	1.22	−0.88	−1.43	0.83	−1.73
H_AGE	0.33	0.50	0.66	0.52	0.38	1.38
H_CLLG	−2.53	2.40	−1.05	0.46	1.51	0.30
H_PUBS	−6.60	5.69	−1.16	7.04	4.34	1.62
H_LARG	−0.85	2.46	−0.35	−1.03	1.69	−0.61
W_EMPF	−2.74	4.09	−0.67	1.71	3.07	0.56
Structural Estimate	10.93			5.53		
		Dependent L_P				
A_P	−0.27	0.75	−0.36	2.47	1.10	2.24
CONST	3.07	19.87	0.15	46.97	31.13	1.51
L_G	−3.09	1.95	−1.58	1.60	3.62	0.44
TFASST	0.27	0.12	2.37	0.38	0.23	1.66
RASST	0.02	0.03	0.67	0.06	0.13	0.50
D_OWN_H	2.76	3.97	0.69	−0.25	5.91	−0.04
ERN_P	5.45	1.94	2.82	2.09	4.09	0.51
NDEPKID	0.45	1.79	0.25	2.07	2.95	0.70
H_AGE	0.35	0.64	0.55	−1.76	0.96	−1.83
H_CLLG	−3.26	3.24	−1.01	0.48	5.09	0.09
H_PUBS	2.43	5.69	0.43	5.03	10.45	0.48
H_LARG	1.38	3.26	0.43	3.27	5.05	0.65
W_EMPF	−15.65	6.09	−2.57	−3.06	11.86	−0.26
Structural Estimate	23.27			26.61		
rho		0.04			−0.43	
N	275 (+,+ = 51; 0,+ = 182; 0,0 = 42[a])			194 (+,+ = 60; 0,+ = 95; 0,0 = 39)		
Log likelihood		−1,373.75			−1,043.98	
		Dependent (ages 40–49)				
L_P	0.11	0.08	1.37	0.10	0.05	1.96
CONST	−39.78	12.77	−3.12	−1.49	11.23	−0.13
A_G	0.83	0.45	1.82	−0.18	0.33	−0.56
TFASST	0.06	0.05	1.20	0.04	0.03	1.05
RASST	0.01	0.01	0.74	−0.02	0.02	−1.07
D_OWN_H	5.02	2.02	2.49	2.43	1.67	1.46
ERN_P	−1.39	0.65	−2.14	0.40	0.42	0.94
NDEPKID	−1.11	1.07	−1.03	−0.47	0.75	−0.63
H_AGE	0.47	0.28	1.65	−0.05	0.24	−0.20
H_CLLG	−0.35	1.51	−0.23	0.39	1.30	0.30
H_PUBS	0.56	2.43	0.23	0.87	2.13	0.41

Table 3.2 (continued)

	1990			1994		
Variable	Estimate	Structural Estimate	*t*-ratio	Estimate	Structural Estimate	*t*-ratio
H_LARG	4.85	1.38	3.52	−0.96	1.47	−0.65
W_EMPF	5.89	1.84	3.20	−1.25	1.53	−0.82
Structural Estimate	7.07			5.40		
		Dependent L_P				
A_P	−0.01	0.77	−0.01	2.18	1.34	1.62
CONST	50.32	20.34	2.47	60.88	27.73	2.20
L_G	−0.83	0.90	−0.93	−0.72	0.89	−0.80
TFASST	0.27	0.06	4.31	0.14	0.09	1.54
RASST	0.04	0.02	2.32	0.06	0.06	0.95
D_OWN_H	2.14	3.37	0.64	−0.29	4.70	−0.06
ERN_P	1.38	0.77	1.80	2.54	0.97	2.63
NDEPKID	3.62	1.54	2.35	0.24	2.14	0.11
H_AGE	−0.94	0.49	−1.94	−1.28	0.65	−1.98
H_CLLG	−3.27	2.79	−1.17	0.56	3.67	0.15
H_PUBS	−5.81	4.65	−1.25	−6.33	4.96	−1.28
H_LARG	3.44	2.85	1.21	2.04	3.80	0.54
W_EMPF	3.51	3.46	1.01	−3.79	4.79	−0.79
Structural Estimate	19.49			23.08		
rho		−0.15			−0.33	
N	304 (+,+ = 69; 0,+ = 201; 0,0 = 34[a])			225 (+,+ = 77; 0,+ = 115; 0,0 = 33)		
Log likelihood		−1,543.97			−1,249.60	
		Dependent (ages 50–59)				
L_P	0.12	0.09	1.26	0.20	0.06	3.24
CONST	5.22	14.09	0.37	−36.37	20.71	−1.76
A_G	−0.19	0.26	−0.74	−0.08	0.31	−0.26
TFASST	0.01	0.04	0.14	0.04	0.05	0.86
RASST	0.00	0.01	−0.10	−0.01	0.02	−0.57
D_OWN_H	0.20	1.86	0.11	1.74	2.46	0.71
ERN_P	0.68	0.37	1.84	0.44	0.44	0.99
NDEPKID	−0.84	0.83	−1.01	1.49	1.01	1.48
H_AGE	−0.21	0.25	−0.84	0.48	0.39	1.22
H_CLLG	−0.19	1.80	−0.10	0.53	1.76	0.30
H_PUBS	1.22	2.33	0.52	2.03	2.37	0.86
H_LARG	0.68	1.41	0.48	−1.71	1.81	−0.95
W_EMPF	−0.49	1.97	−0.25	−0.87	2.67	−0.33
Strutural Estimate	5.71			6.59		
		Dependent L_P				
A_P	0.70	0.98	0.71	1.31	0.61	2.13
CONST	48.84	29.31	1.67	37.34	42.91	0.87
L_G	−0.16	0.60	−0.27	0.81	0.66	1.22
TFASST	0.31	0.06	5.12	0.42	0.08	4.95
RASST	0.00	0.01	0.21	0.01	0.03	0.17
D_OWN_H	2.85	4.87	0.58	11.88	5.38	2.21
ERN_P	0.45	0.66	0.68	−0.03	0.84	−0.04
NDEPKID	0.24	1.75	0.14	−2.53	2.42	−1.05

(*continued*)

Table 3.2 (continued)

	1990			1994		
Variable	Estimate	Structural Estimate	*t*-ratio	Estimate	Structural Estimate	*t*-ratio
H_AGE	−0.86	0.52	−1.64	−0.90	0.77	−1.16
H_CLLG	−4.02	2.79	−1.44	1.28	4.20	0.30
H_PUBS	1.97	4.31	0.46	−3.63	6.02	−0.60
H_LARG	6.59	2.79	2.37	3.52	3.85	0.91
W_EMPF	1.08	3.66	0.29	0.98	5.87	0.17
Structural Estimate	16.25			19.93		
rho		−0.13			−0.33	
N	210 (+,+ = 60; 0,+ = 124; 0,0 = 26[a])			191 (+,+ = 76; 0,+ = 82; 0,0 = 33)		
Log likelihood		−1,067.76			−1,054.73	

Note: N = Number of observations. See text for explanation of variables.
[a] +,+, 0,+, and 0,0 indicate (AP > 0, LP > 0), (AP = 0, LP > 0), and (AP = 0, LP = 0), respectively.

The theoretical model predicts that the coefficient on L_P in the A_P equation and the one on A_P in the L_P equation are both negative. Contrary to this prediction, neither coefficient comes out significantly negative, and both are positive and significant in five out of twelve instances (three age groups, two waves, and two dependents). Although the coefficients on A_G in the A_P equations and on L_G in the L_P equations tend to have negative signs as I expected, they are not significant, except in one case (ages thirty to thirty-nine in 1990). Based on these results, I cannot say that this model specification and estimation are correct descriptions of household asset choice.

There are several possible explanations for this result. First, measurement error in A_P and L_P are unavoidable in this data set, and can cause bias in estimates. However, this cannot explain consistent positive signs of endogenous variable coefficients.

A more plausible explanation of the positive signs may be that they are caused by a positive association between A_P and L_P. The main reason for this association may be heterogeneity in time preference. That is, those who have higher time (future) preference tend to have higher A_P and L_P, and vice versa. When we can successfully control for time preference by including variables representing it, we can expect to observe a trade-off between life insurance and personal annuity. My results indicate that the control variables included in the model are not rich enough to explain heterogeneity in time preference.

3.4.2 Reduced-Form Estimates

Although tight parameterization in theoretical models is not enough to explain the observed pattern of asset holding, it is interesting to see how holding private annuities and life insurance is affected by exogenous variables.

To examine how households reacted to a decline in asset values and reduced pension benefits between the two waves, I estimate tobit regressions of A_P and L_P for a set of exogenous variables: L_G, A_G, TFASST, NDEPKID, and other control variables. As in the structural form, the observations are divided into six groups: three age groups and two waves (1990 and 1994).

3.4.3 Marginal Effects

Table 3.3 and figure 3.1 summarize the marginal effects on A_P and L_P of public pension (A_G), public life insurance (L_G), total financial asset (TFASST), number of dependent children (NDEPKID), and intercept (CONST).

In table 3.3, tests of significance of individual coefficients are indicated in column *t*, and tests of equality of coefficients in 1990 and in 1994 ($\beta_{i90} = \beta_{i94}$) are indicated in column *s*. Except for a few cases, the marginal effects of these variables change by age group within the same wave. I do not present results of formal statistical tests, but it is obvious that the marginal effects change with one's life stage.

The coefficients of A_G in the A_P equation are significantly negative for people in their thirties in both 1990 and 1994: −1.247 in 1990 and −0.649 in 1994. This implies that, holding other variables constant, reduction in public pension benefits is countered by roughly the same amount of increase in private annuities for this age group. In other age groups, the marginal effects are insignificant or positive (as for those in their forties in 1990).

The effects of public life insurance (L_G) on private life insurance (L_P) are all negative in 1990 and are significant for those in their thirties and fifties. This strongly supports the life-cycle hypothesis. The effects are insignificant in 1994, however. Also, the coefficient for A_P in 1994 is significantly positive, which again supports the life cycle hypothesis.

The effects of total financial assets are mostly positive and significant as one would expect. However, the marginal effects on A_P increased significantly from 1990 to 1994 for those in their thirties and fifties. The number of dependent children (NDEPKID) has a negative effect on personal annuities (A_P) for two age groups, household heads in their thirties and their forties. The coefficient is significant for the latter group in 1990, and for the former group in 1994. It may be that when parents are younger (and presumably their children are young), they place a higher priority on investing in their children rather than preparing for retirement. Also, the effect of NDEPKID on L_P is significantly positive for those in their forties in 1990. These two observations support the bequest motive. In 1994, however, all the coefficients for L_P become insignificant. This pattern suggests that the bequest motive had become negligible by 1994.

A possible reconciliation of these conflicting observations is that, faced with less optimistic future prospects for their children and themselves,

Table 3.3 **Marginal Effects Based on Reduced Form Estimates**

		A_P					L_P				
	Age	1990	*t*	1994	*t*	*s*	1990	*t*	1994	*t*	*s*
A_G											
	30s	−1.25	**	−0.65	*		1.95		−4.21	*	*
	40s	0.75	**	−0.34		**	−0.14		−0.02		
	50s	−0.20		0.17			2.51	**	−1.29		**
L_G											
	30s	0.13		1.64	**		−5.38	*	7.63	*	**
	40s	−0.22		−0.01			−0.74		−0.90		
	50s	0.17		−0.23			−2.01	**	0.89		**
TFASST											
	30s	−0.02		0.12	**	**	0.27	*	0.59	**	
	40s	0.08	**	0.06	**		0.28	**	0.17	*	
	50s	0.03	*	0.11	**	**	0.32	**	0.41	**	
NDEPKID											
	30s	−0.61		−1.87	**	*	2.11		0.23		
	40s	−0.70	**	−0.29			3.60	**	0.34		
	50s	−0.42		0.90	*	**	1.27		−0.26		
CONST											
	30s	−8.64		−0.53			−39.02		132.07	**	**
	40s	−39.34	**	3.22		**	52.13	*	63.76	*	
	50s	2.96		−4.81			53.17	*	18.82		

Notes: t indicates test of significance. *s* indicates test of difference, $\beta_{i90} = \beta_i$. See text for explanation of variables.
**Significant at the 5 percent level (two-tailed).
*Significant at the 10 percent level.

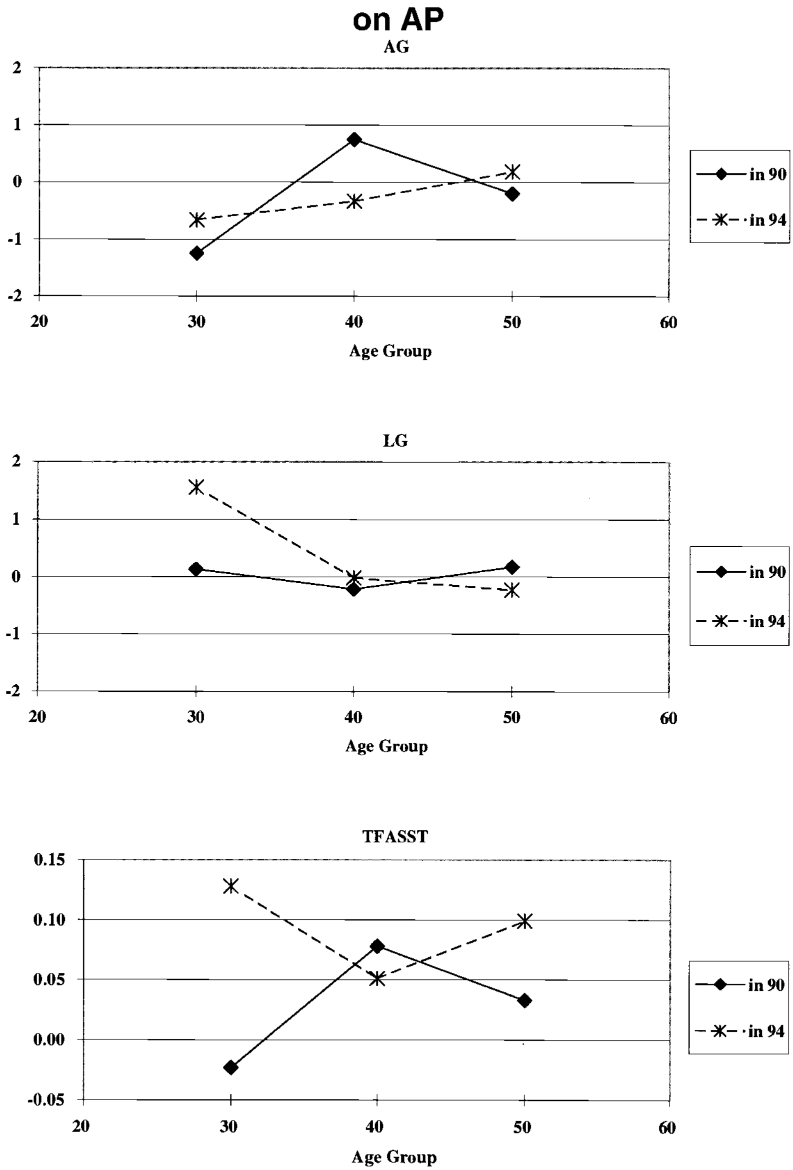
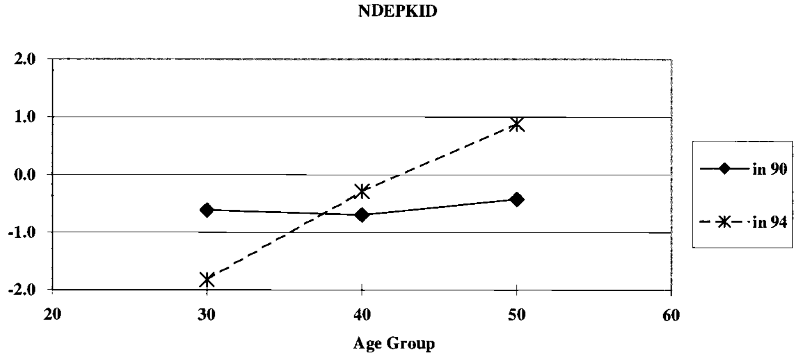


Fig. 3.1 Marginal effect

parents make a priority of leaving bequests to their heirs by investing in education, which yields a higher return than monetary assets in the long run. Their second priority is preparing for retirement. To that end, they purchase personal annuities and trade in their monetary assets. When they are younger, the purchase of A_P is more dependent on the level of total



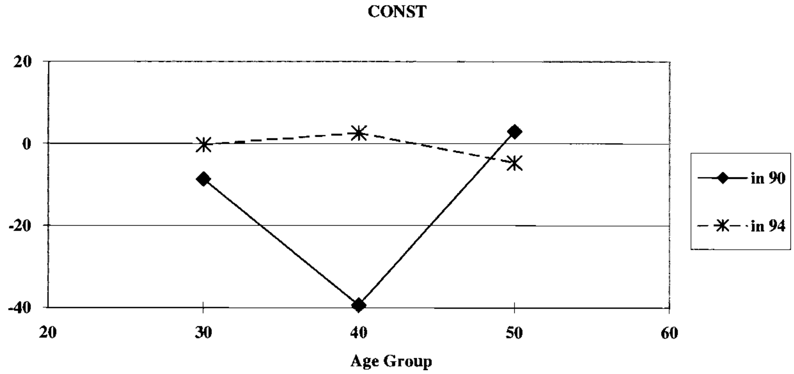


Fig. 3.1 (cont.)

financial assets and the number of dependent children; the marginal effects of those two factors are large.

The level of the intercept coefficient itself is not of interest, but its shift between the two waves reflects a uniform adjustment made by the people within the same age group. The intercept showed a significant increase for the group in their forties in the A_P equation, and for those in their thirties in the L_P equation. The marginal effects of other variables on A_P are very stable for people in their forties. This implies that, facing a reduction in pension benefits, those in their forties raised their private annuity holdings, regardless of the level of other factors. These adjustments presumably were made by a compensating reduction in other financial assets.

It is difficult to explain all of these results in one simple framework. However, it seems that household priorities regarding these two objectives, their own retirement life and the later life of their surviving family members, change with both their life stage asset levels and their expectations for the future. One common pattern suggested by these estimation results is that a households' first priority is to achieve at least a minimum level of

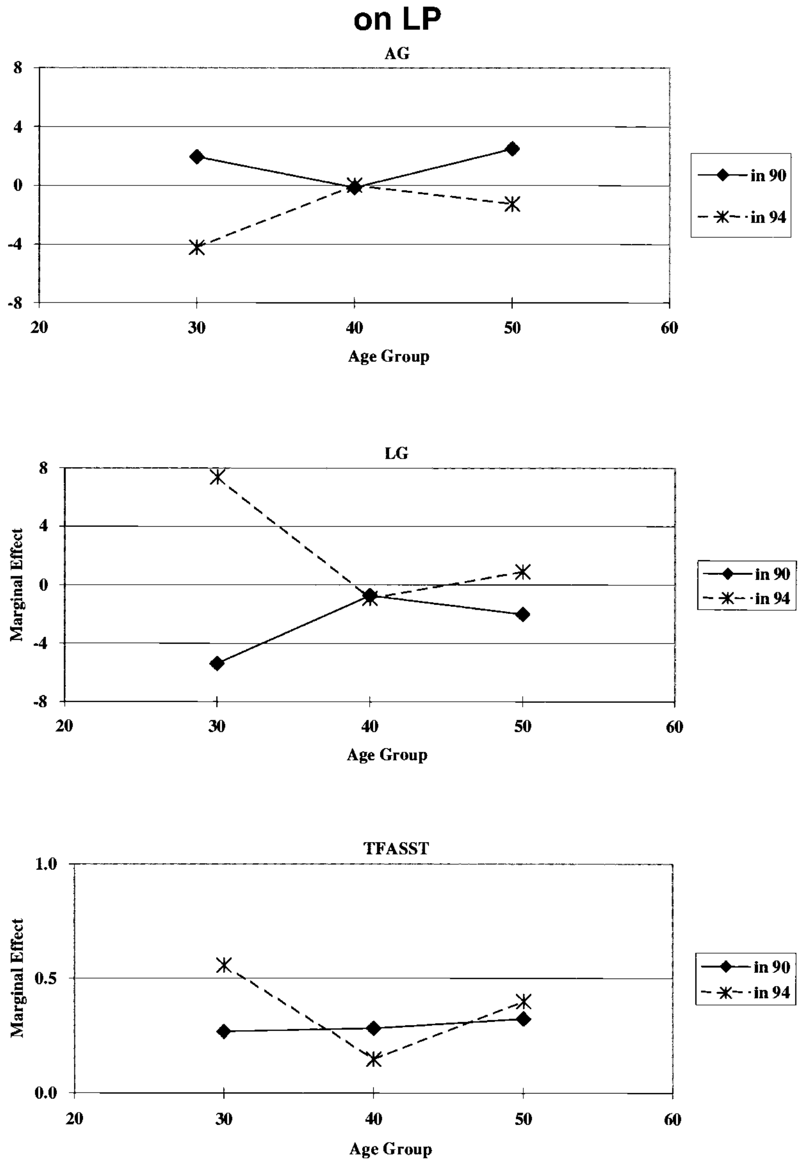
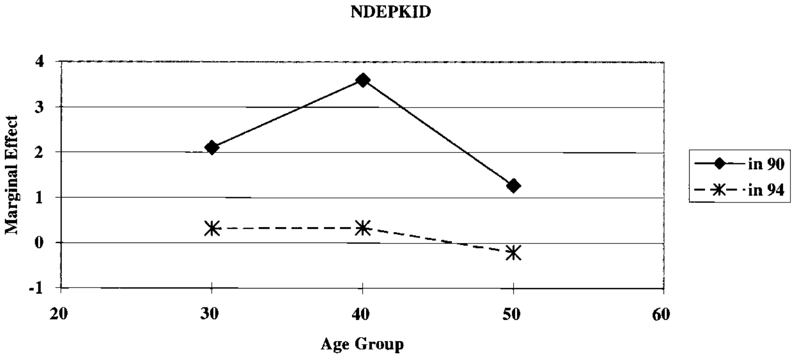


Fig. 3.1 (cont.)

preparation for retirement and a minimum level of bequests to their heirs. For that purpose, they are willing to sacrifice current consumption.

We also look at changes in total annuity and life insurance demand in the two waves. The sum of the predicted values of private annuities from the tobit coefficients and public pensions (A_G) may be interpreted as "de-



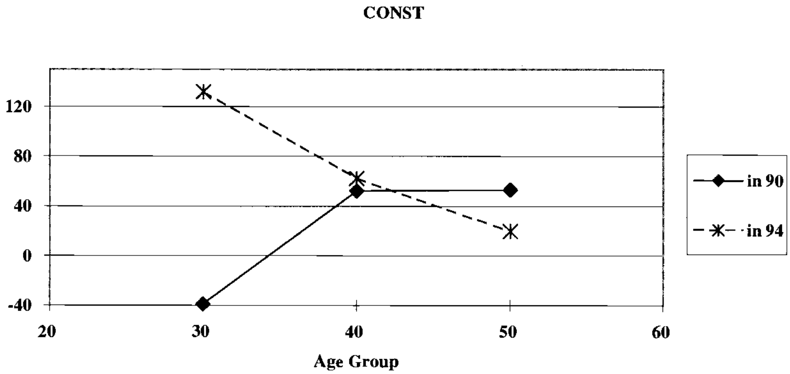


Fig. 3.1 (cont.)

sired total annuity." The same interpretation applies to life insurance. I look at the level and shift of these total annuity and life insurance variables. Table 3.4 and figure 3.2 present means and standard deviations of these two variables for six age groups: thirty to thirty-four, thirty-five to thirty-nine, and so on, up to fifty-five to fifty-nine.

As the upper half of figure 3.2 shows, the mean total annuity increased in all age groups by 2 million (for those aged fifty-five to fifty-nine) to 4.5 million yen (for those forty-five to forty-nine). Younger generations tend to start accumulating annuities earlier in the 1994 data. Within the 1994 wave, the means of total annuity are fairly stable across age groups, with a range of 2.9 million yen (15.6–18.5 million yen). Variations within and across age groups are stable, with the standard deviations between 5 and 6 million in both years.

A contrasting picture emerges for total life insurance. The lower half of figure 3.2 shows that the means of total life insurance stayed at about the same level in both years. The variation within each age group, on the other hand, increased in all age groups, with those aged thirty-five to thirty-nine

Table 3.4 Desired Life Insurance and Annuity, by Age Group

	1990		1994	
Age	Mean	Standard Deviation	Mean	Standard Deviation
		Total Annuity		
30–34	12.77	6.39	16.72	6.03
35–39	12.91	6.05	17.02	5.37
40–44	14.49	5.66	17.35	6.07
45–49	14.05	5.25	18.52	9.00
50–54	14.18	5.00	16.31	7.98
55–59	13.85	5.76	15.61	5.73
		Total Life Insurance		
30–34	28.78	8.58	32.35	12.56
35–39	35.31	8.99	33.90	18.36
40–44	35.24	8.82	35.29	11.78
45–49	34.10	9.40	33.86	11.84
50–54	27.72	9.39	29.91	13.79
55–59	26.20	12.91	27.19	15.30

Note: Total annuity is the sum of predicted private annuity and life insurance (million yen). Total life insurance is the sum of public pension and life insurance (million yen).

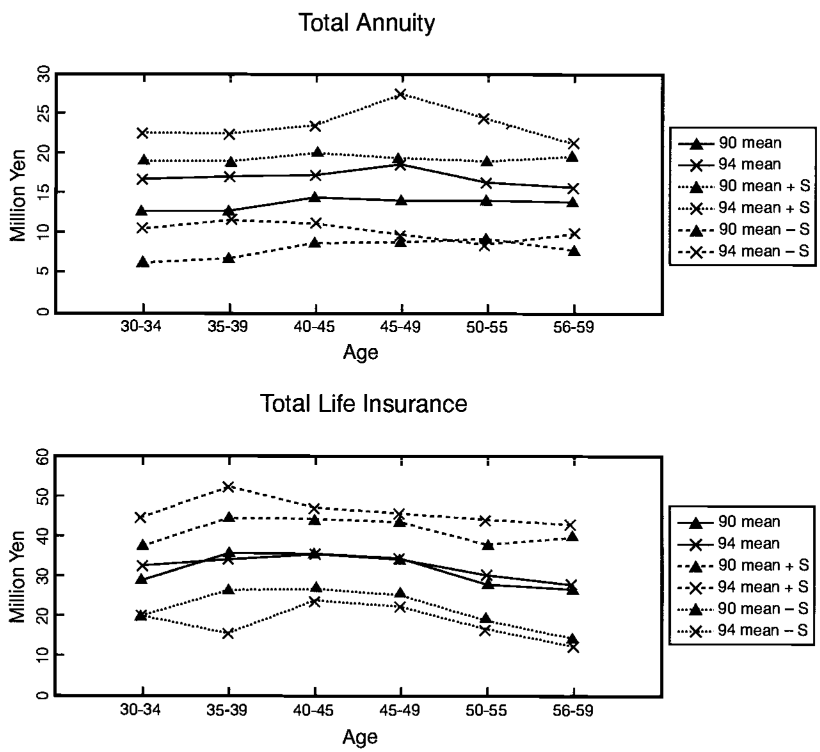


Fig. 3.2 Desired total annuity and life insurance

having the largest variation. As noted earlier, this age group is the first generation of both males and females to begin receiving full pension benefits beginning at age sixty-five. The response to the shift in the public pension system is more heterogeneous in this age group than in other groups.

3.5 Conclusion

This study examined the relationship between Japanese households' personal annuity and life insurance choices and the public pension system. From the two waves of microdata sets obtained in 1990 and 1994, I separate pure life insurance and pure annuity from their gross values, and thereby isolate the saving component of life insurance and personal annuity. The sample period is characterized by declining asset values, a reduction in public pension benefits, and less optimistic future prospects for the Japanese economy.

I find that the intended level of total annuities increased by about 4 million yen on average from 1990 to 1994, which more than compensated for a reduction in public pension benefits. Furthermore, the age profile for mean total annuities became flatter from 1990 to 1994 across all age groups because of the younger generation's early accumulation of personal annuities. In contrast to total annuities, the mean total of life insurance stayed quite flat and stable in both periods across age groups, while intragenerational variations widened to as much as twice their 1990 levels.

One hypothesis to explain this result is that households have a minimum target level of annuity and bequest. Facing declining benefits from public pensions and unfavorable future income prospects, individuals begin to accumulate personal annuities at earlier stages of their lives. To leave a bequest, it is a rational choice to invest in the asset that yields the highest return to heirs, namely, education. If parents decide to leave a bequest in the form of human capital via education, they are constrained during the period of high educational expenses. Since educational expense is lumpy in nature, households must reduce their consumption, saving, and life insurance purchases during this period, typically beginning in their mid-thirties and up to their early fifties. Once the minimum level is achieved, households choose their consumption/wealth accumulation path from a wider variety of menus.

These results are consistent with Horioka et al.'s (1996) finding that, in Japan, the purpose and priority of wealth accumulation (saving) changes with age and life stage. In particular, the primary purpose of saving among those in their thirties is education, while for those over forty-five it is preparation for retirement.

Appendix

Japanese Social Security System

This section gives an outline of Japan's social security system, which provides public pensions and public life insurance (see Social Insurance Agency 1995a,b; Shimada 1995 for details). Old-age public pensions provided by the Japanese system have two parts: the base (fixed) part, and the remuneration (proportional) part, which is also called the "second floor."

Base Part

The base of the system is the National Pension (NP, or Kokumin Nenkin). It is compulsory for all individuals aged twenty to sixty. Those who paid the premium for the NP will receive a fixed annual payment beginning at age sixty in the 1985 system, and beginning between age sixty and sixty-five (depending on year of birth) in the 1994 system (see fig. 3A.1).

Benefits from the NP include Old-Age Basic Pension, Survivors' Basic Pension, and Disability Basic Pension. The insured person who has paid the premium for more than twenty-five years is eligible for Old-Age Basic Pension benefits. Those who paid the premium for forty years will receive full benefits: 666,000 yen per year in 1990, and 780,000 yen in 1994. The

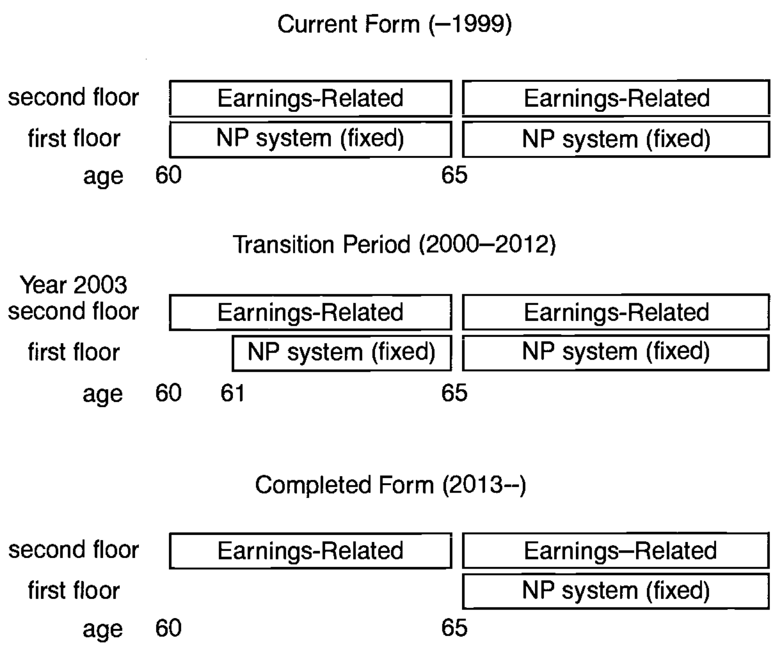


Fig. 3A.1 Transition of social security system (1985–94)

Survivors' Basic Pension benefit depends on family composition and the age of the widow.

Second Floor

The proportional remuneration consists of various employees' pension systems. Among those, the Employees' Pension Insurance system (EPI, or Kōsei Nenkin) is the most common one in Japan. It covers all employees in the private sector, excluding only public employees, teachers and employees of private schools, and seamen. Those insured by EPI pay the premium according to their remuneration level, and upon reaching their retirement age (sixty), they receive pension payments based on their premiums. Employees not covered by EPI are covered by mutual aid associations (MAA, *kyō-sai kumiai*), which offer similar premium/benefits schemes as the EPI, to the insured. The premiums for the EPI are determined on the basis of "standard remuneration," SR, which is basically equal to the regular monthly wage and allowance, excluding bonus payments. The premiums are determined by the SR multiplied by the prescribed ratio.

The benefit levels of the Old-Age Employees' Pension and the Survivor's Employees' Pension are determined as follows:

Old-Age Employees' Pension =

$$(\text{Average Monthly SR})x(1\% \sim 0.75\%)^{*}x(\text{Insured Period in Months}),$$

where x is the indication ratio and the asterisk indicates that the ration varies by the year of birth.

Survivor's Employees' Pension is paid to the surviving family members when the insured person dies. The pension is 75 percent of the Old-Age Employees' Pension, and an additional amount is paid if there are children under eighteen years old, or if the widow is of advanced age.

Calculation of Public Life Insurance (L_G)

The life insurance part of social security (L_G) is defined as the expected value of a discounted sum of social security payments:

$$\sum_{t=\text{H\_AGE}+1}^{80} \text{SSB}_t \times \Pr(\text{Die at age } t \,|\, \text{Alive at age H\_AGE}),$$

where SSB_t indicates the discounted sum of social security benefit flow when husband dies at age t (>H_AGE). SSB_t is obtained under the following assumptions:

1. The householder started working at the age indicated in the following table, and did or will pay social security premiums throughout the employment period.

Final School Attended	Age When Started Working
Junior high school	17
High school	20
Junior college	22
College	24

2. The wage profile of the husband before and after the survey, up to his death, is given by equations from Iwamoto and Furuie (1995), which were obtained from cross-sectional regressions of the 1990 RADAR data.
3. The SR when the husband dies at age t is the average wage of the husband before his death multiplied by the factor determined by the firm size.
4. The couple will not have additional children after the RADAR survey.
5. The discount rate is 1/1.05.
6. The indexation factor is 1.01 (1 percent annual growth).

Family Composition

RADAR asked questions on the number of dependent children and the family's life stage, but did not ask the ages of the children. In order to obtain the social security benefits flow for the surviving family members, I assume that the ages of the children are given by the following table.

Life Stage	Description	Age of the Eldest Child
3	First child is born.	3
4	First child is in elementary school.	9
5	First child is in junior high school.	14
6	First child is in high school.	17
7	First child is in college.	21
8	First child becomes independent.	25

The age difference between children is assumed to be two years. If the age of the youngest child becomes negative by this convention, then the age of the youngest is set to be zero and all ages are spaced evenly between the eldest and the youngest.

Life Insurance (L_P)

The following variables on life insurance are used to calculate the expected life insurance payment to surviving family members. Note that survey questions regarding the types of insurance held by the household differ in 1990 and 1994.

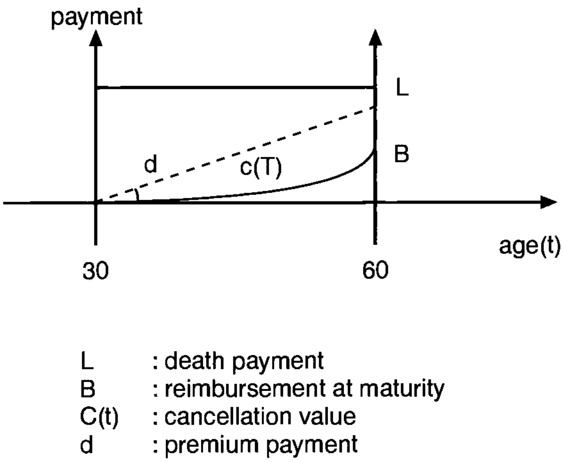


Fig. 3A.2 Life insurance

1990

1. Husband's death insurance payment (LI_H), and the amount of reimbursement at maturity (LI_B).
2. Types of insurance purchased by the household. Dummies for:
   a. term insurance (D_TI);
   b. insurance with maturity and reimbursement (D_MR);
   c. insurance with maturity (D_M);
   d. whole life–type insurance (D_WL).

1994

1. Husband's death insurance payment (LI_H), and the amount of reimbursement at maturity (LI_HB).
2. Types of insurance which cover husband. Dummies for:
   a. term insurance (D_TI);
   b. whole life–type insurance (D_H_WL);
   c. saving-type insurance (D_H_SV).

As mentioned earlier, life insurance has two functions: pure term and savings (see fig. 3A.2). To measure the amount of bequest from life insurance, I look at the expected discounted value of life insurance payment, net of saving. This approach makes it possible to compare benefits from public life insurance and private life insurance.

The expected life insurance payment to surviving family members is calculated by the following formula:

$$\sum_{t=\text{H\_AGE}+1}^{80-\text{H\_AGE}} \rho^{t-\text{H\_AGE}} \times \text{Death Insurance Payment} \\ \times \Pr(\text{Die at age } t \,|\, \text{Alive at age H\_AGE}),$$

where ρ is the discount factor, which is set to be 1/1.05. The conditional probability of death at age t given that the husband is alive at age H_AGE is calculated from the seventeenth Japanese mortality table, based on the 1990 population census. The summation is taken up to age eighty, because the conditional death rate is not available for age eighty and over.

The saving component of life insurance at time t is defined as reimbursement for canceling the contract at time t. I obtain the figures under the following assumptions:

1. Household purchased the contract at age thirty.
2. Premium is paid by annual (or monthly) installment.

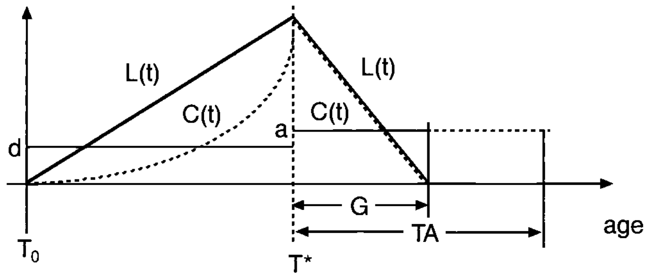
Calculation of Personal Annuity (A_P)

The following variables relating to private annuity are available in RADAR.

1. Dummies for subscriber as husband or wife (multiple answer is possible).
2. The expected total annual annuity payment upon retirement.
3. Duration of receiving annuity. Dummies for
   a. whole life (D_PA_WL);
   b. over eleven years (D_PA11);
   c. six to ten years (D_PA6_11);
   d. five years or less (D_PA_5) (multiple answer is possible).

The typical personal annuity arrangement is in the following form (see fig. 3A.3): The contract holder pays a fixed annual installment, d, until age $T^* - 1$ (typically age fifty-nine or sixty-four). At age T^*, he starts receiving an annuity of A for TA years. If he dies before age T^*, his surviving family receives roughly the amount of total installments paid before his death. In the case of death during the annuity period, the heir will receive the remaining balance of the annuity payments during the guarantee period, G years. For example, if the husband dies at age t, $T^* < t < T^* + G$, the payment is roughly $A(T^* + G - t)$. There is no payment to his heir if the holder dies after age $T^* + G$. Also, if he cancels the contract before age T^*, reimbursement is paid according to the pre-specified schedule (see fig. 3A.3). In the case of cancellation after age T^*, the payment is the same as in the case of death.

Thus the personal annuity contract has three functions: personal annuity, life insurance, and saving (cancellation value). The total figure of personal annuity receipt of the household is in the questionnaire, but other information about husband's annuity, such as amount of coverage for the husband, age of the person when the contract was signed, (T_0), age when the person starts receiving the annuity (T^*), period of receipt (TA), or the guaranteed period (G), are not available.



T_0 : Age at contract
T* : Age, start receiving annuity
G : Guaranteed period
TA : Annuity period
a : annuity
d :premium
L(t) : Life insurance payment
C(t) : cancellation value

Fig. 3A.3 Personal annuity life insurance

I construct the cancellation value, the discounted expected sum of annuity flow, and the life insurance under the following assumptions:

1. Personal annuity contract started when the husband was age thirty ($T_0 = 30$).
2. Premium is paid by annual (or monthly) installment.
3. Husband will start receiving annuity at age sixty ($T^* = 60$).
4. There are three types of personal annuity: ten-year guarantee/whole life ($G = 10$, $TA = \infty$); five-year fixed ($G = TA = 5$); and ten-year fixed ($G = TA = 10$).

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