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Doctoral Thesis

# Japanese Household's Precautionary Saving and Public Pension Choice

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# Chapter 1

# Microeconomic Analysis of Dropouts of The national pension System[*]

*Abstract*

Employing microdata about dropouts of the national pension system, this paper tries to verify the existence of "adverse selection" phenomenon in Japan's national pension system. Three factors are likely to motivate the drop out behavior of the insurants: the liquidity constraint, relatively short life expectancy and generation unfairness of net pension benefit. The last two factors are integrated with adverse selection hypothesis.

First, fundamental theoretical models about dropout motivations are discussed, then the seemingly unrelated national pension and public pension choice are regressed by employing the Bivariate Probit Model. Our major results can be summarized as follows: (1) not only the significance of the liquidity constraint are confirmed but also the adverse selection hypothesis is fully supported, (2) the impact of adverse selection motives on dropout decision of the insurants are stronger than that of the liquidity constraint motive, (3) the probability of dropping out from the national pension system will be 0.24%-0.41% higher for every one year younger, 5.1%-11.1% higher for the unemployed, 0.55%-1.1% higher for every 1 million yen reduction or financial assets.

## *1. Introduction*

Although theoretically every Japanese national has the obligation to join the national pension system, the existence of a large amount of dropouts is well known. According to the statistics of the Social Security Agency (2000), the number of

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[*] Partial the work in this chapter is joint research with Wataru Suzuki and this joint research was published in Japanese as Suzuki & Zhou (2000). We would like to thank Prof. Charles Yuji Horioka (Special Chief Researcher of Ministry of Posts and Telecommunications), Prof. Colin McKenzie, Prof. Naohiro Yashiro, and the members of Professor Horioka and Professor McKenzie seminars at Osaka University for their numerous helpful comments.

dropouts who should have been the type I insurants[1] amounted to over 990 thousand in 1998, which means the drop out rate was as high as 4.9%. On the other hand, SSA (1997a) indicates that there are 1.72 million dropouts and 3.34 million insurance premium waivers in 1996, which altogether account for about 30% of the targeted Type I insurant population. In a word, Japan's national pension system is about to face a critical state of "hollowing". Three factors are considered to be possible motives for the choice of dropping out from the national pension system. First, the longest recession in Japan since World War II has resulted in high unemployment and a reduction in income of households. Therefore, households may face much tighter liquidity constraint than before, and those that could not pay the insurance premium are obliged to become dropout of the public pension system (liquidity constraint factor). Second, people who are relatively short lived because of bad health conditions or who regard that their future benefit will be lower than those with long lives will choose to drop out from the system (life expectancy factor). Finally, as young generations are expected to suffer net loss if they remain in the system because of the upsurge of insurance premium and the reduction of benefits with the aging population and the declining birth rate. Some of them may therefore refuse to join the system (generation gap factor). We regard the last two factors (life expectancy factor and generation gap factor) as supportive conditions of the adverse selection hypothesis[2].

It is one of the most important subjects to distinguish these motivations when managing public pension policies. If the liquidity constraint is the motivation for dropout behavior, policies such as expanding the application range of insurance

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[1] Type I insurants include the self employed and their spouses, students older than 20 and other salaried workers in companies with less than five employees.

[2] Hypothesis of adverse selection suggests that mere relatively high risk holder will remain in the pension system when uniform insurance premium is fined to all insurants because of the asymmetry of information.

premium waiver or postponing its payment should be considered. On the other hand, financing of the public pension system will face even huge crisis and bigger reform will be required if the factors of adverse selection are confirmed.

By employing micro data about dropouts of Japan's National Pension System, this paper investigates the motivation for dropping out from the system and verifies the existence of the "adverse selection" hypothesis. The organization of the paper is as follows: the literature review is set out in section 2, the basic models and dropout motivations are presented in section 3, and the data used in the analysis are described in section 4. The main empirical results are presented in section 5, and our conclusions are summarized in section 6.

## *2. Literature Review*

Most of the preceded studies have suggested the arrears or dropping out problem of the national pension is a problem of "adverse selection" or "distrust toward public pension system", but this has never been tested scientifically. As Japan is experiencing the longest recession since World War II, the high drop out rate of the national pension system can very possibly be determined by other factors such as the liquidity constraints (Ushimaru 1999; Oshio 1998; Hatta & Oguchi 1999; Takayama 1998). Therefore, it is hard to say that adverse selection and distrust toward the public pension are the sole determinants of the high dropout rate of the national pension and it should be very important to verify the significance of all the previously mentioned factors statistically.

There has been very little empirical research on the dropout problem in Japan with the exception of Ogura &Chiba (1991), Tsukahara (1997) and Ogura & Kakuda (2000). Ogura & Chiba (1991) regressed the estimated dropout rate from the national pension from 1973 to 1988 on the insurance premium, labor income of self employed and labor market factors and concluded that the dropout rate is sensitive to fluctuations of the insurance premium. In a self-constructed survey, Tsukahara

(1997) made the first attempt to ask directly about the "participating tendency toward the national pension if they can choose freely" and "expected life expectancy" of respondents. According to his data tabulations, he rejected the adverse selection hypothesis that the shorter, a person's life expectancy the more likely they were to drop out from the pension system. However, as he himself has realized, this result should be accepted with reservations because the tabulations fail to control various important factors before reaching the conclusion. Employing some large scale survey data, Ogura & Katoda (2000) [3] investigated the existence of the generation gap in pension benefit. Although the paper does not discuss only the national pension problem, the payment of the social security premium is explained using a probit model. Ogura & Katoda (2000) find that: a) variables relating to present or past income, employment status and age all significantly affect the payment of social security premium; and b) young cohorts are more likely to not pay the social insurance premium.

On the other hand, government-led surveys about dropouts include SSA (1997b,2000). Their major results can be summarized as follows: a) young people or metropolitan residents have a higher drop out rate from the national pension system. b) There are no significant differences in labor income or consumption between the group of participants and that of the dropouts, but the average saving of dropouts is somewhat less than that of participants. c) Participation rates in life insurance, private pension or medical insurance of dropouts are not significantly different from those of participants. However, all of the above results are based on simple descriptive statistics or Figures. As many primary factors have not been controlled for, there is some doubt about the validity of these results. For example, the apparent relationship between age and drop out rate may be caused by the real relationship between income and drop out rate. In addition, after controlling for the effects of the income and employment variables, dropouts may be more inclined to

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[3] Because the data of "Basic Survey about National's Living" can not distinguish arrears or dropouts of the pension system from those of the medical care system, this paper pools them

join a private pension system or take out life insurance. The present paper improves upon the probit model Ogura & Katoda (2000) employed and applies it to deal with these problems.

### *3. Model of dropout motivations*

Although the National Pension Law has required that type I qualifiers of the national pension must hand in the application forms no later than two weeks after the confirmation of their qualification (Item 12-1), violators are subject to a fine of no more than 100 thousand Yen(Item 113). As a result, type I qualifiers can possibly choose to escape the payment of the insurance premium at the risk of punishment or loss of their retirement benefit. In other words, adverse selection behavior is possible for these type I qualifiers. In addition, although the insurance premium of national pension is fixed, the amount of the pension benefit is adjusted according to the length of the participation period. The amount of the pension benefit (PB) depends on the participation period as follows:

1) For those who have participated for more than 40 years …
   PB=780,000 yen/Year (65,000 yen/Month)
2) For those who have participated between 25 and 40 years…
   PB=780,000*(months of insurance premium payment +1/3 months of waiver)/480 yen/Year
3) For those who have participated for less than 25 years … PB=0

Therefore, the amount of the pension benefit can be adjusted with the participation period in a range of 25/40-40/40 of the full amount. In other words, a typical insurant can be a dropout of the national pension system from 0 to 15 years but still receive some amount of pension benefit after retirement given that he starts working at 20 and retires at 60.

A model of the above pension benefit system can be simplified as in figure 1. First,

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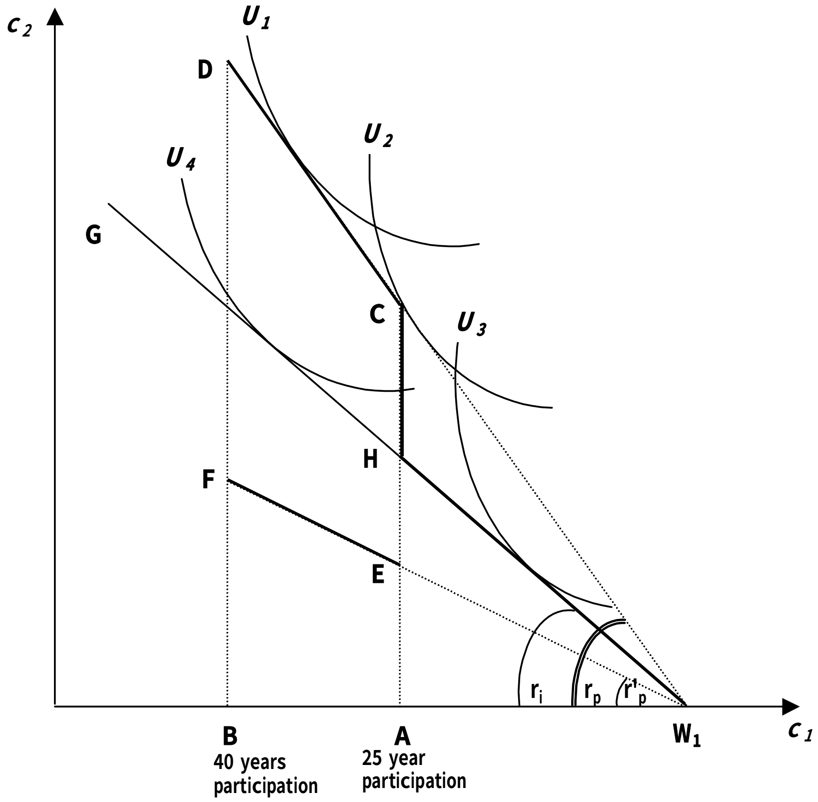
together.

the lifetime is divided into two periods: the young period (Period 1) and the old period (period 2). People use labor income of period 1 (W1) to pay for the national pension insurance premium and receive pension benefits for consumption in period 2.

Figure 1: Model of drop out motivation



Given the national pension is the only available pension, W1-A-C-D will be the budget constraint line. A(C) and B(D) refer to the point of 25 years and 40 year participants respectively. As insurants with a participation period of less than 25 years will receive no pension benefit, line W1D is overlapped with the horizontal axis. The slope of CD represents the profitability of national pension. On the other hand, W1-G refers to the budget constraint line in the case of a private pension whose profitability is $\gamma_i$. As the system is profit-free and the transfer from national will be added to support the system, the profitability of the national pension run as a pay-as-you-go system should be higher than the theoretically fair profitability rate. Therefore, the slope of the private pension is somewhat lower pictured than that of the national pension. As a result, national pension qualifiers of type I should be facing a budget constraint like W1-H-C-D (the blackened line in Figure 1).

Individuals maximize their total utility in period 1 and period 2: max $U_i = u(c_1) + \rho_i u(c_2)$, where *u()* is a strong concave function, $\rho_i$ is the life expectancy of person i. For example, given the life expectancy of person 1 is longer than that of person 2, the slope of the utility function of person 1 should be flatter than that of person 2. Therefore, the utility maximization point of person 1 (U1) should be above and to the left of that of person 2 (U2). Individuals can choose their optimal participation period of the national pension system according to their life expectancy. Given somebody's participation period shorter than 40 years, the gap between 40 and his real participation years should be regarded as a result of a "optimal choice". Moreover, given somebody's life expectancy is quite short, he can even choose to join private pension instead of national pension system such as U3. People with low risks can choose to shorten their participation period to the minimum 25 years or 0 year, and people with high risks will, of course, choose to stay in the national pension system. That is to say, the phenomenon of "adverse selection" occurs. Special attention should be paid to the turning point C where many people should not have chosen this point given their national pension budget line were continuous (U2). So many people should be aggregated at the point of 25 years participation. If the above model is true, the maximum age of realizing 25 years participation should be those aged between 35 and 39, whose participation rate will have a jump compared to other age groups.

When turning to the problem of generation gap of national pension benefit, the studies of Tachika & Kaneko & Hayashi (1996) and Hatta & Oguchi (1999) should be mentioned. According to Hatta & Oguchi (1999), individuals born in 1935 will have a net benefit of 9.71 million Yen and those born in 1995 will adversely have a net loss of 3.02 million yen if participating in the system. It is the individuals born in 1970 that will have neither a gain nor a loss. The fact that the older an individual the bigger the gain or the younger an individual the bigger the loss is primarily decided by the pay as you go financial system of the national pension. As retirees keep increasing with Japan's aging population, the working population has to pay more insurance premium and probably receive less after retirement than before in order to balance the pension budget. As a result, the inequality among generations happened. Line W1-A-E-F represents the public pension budget line of the young generations that will have a net loss. The profitability of the national pension for those young generations ($r'_p$) will not only be lower than the theoretical fair profitability but also be lower than the private pension profitability. For these young generations, as the budget constraint line of private pension will always be higher than that of the national pension, private pension should be chosen no matter what their life expectancies are. In addition, the younger an individual the larger the profitability gap between private pension and the national pension. As a result, if the above model is true, the data should support the hypothesis that the younger the individual the higher the probability of dropping out from the national pension system or join private pension system.

Finally, the existence of liquidity constraints can be tested by investigating whether the consumption of period 1 is very close to the point of W1 or not. If it is, people may be obliged to drop out from the national pension system because of a liquidity constraint.

## *4. Data*

This study uses data on 611 Japanese households taken from the 1996 survey on the Financial Asset Choice of Households (SFACH), a survey of 3,942 households whose household heads are aged 20 years or older. The sample is selected on the basis of a multiple-stage stratified sampling procedure. This survey collected very detailed data on the consumption, income, pension and retirement plan of Japanese households. Moreover, this survey includes detailed information about the status of private pension[4] and attributes of households such as gender, age, employment, health condition, education, residence, income, financial assets and real assets. A more detailed discussion of SFACH (1996) is continued in Appendix I.

The number of observations was reduced to 611 in three stages. First, we retain only households where the household head is aged between 20 and 59. We exclude samples of spouse because their pension participation is decided not only by their own profession or income, but also by the profession of their husband[5]. Those who are older than 60 are generally retirees in Japan and are therefore outside the scope of our discussion. Second, we dropped all individuals except those participating in the national pension system only or those who have not joined the public pension system. Insurants of earning related pension are excluded because their insurance premium is compulsorily drawn out from their salaries. Finally, student households are also excluded because most of them are still economically dependent on their parents.

Among the 611 samples, about 10% (60) people have no public pension. Just as predicted, the dropouts of the national pension have less income, education, financial assets and real assets than the participants have. In addition, their unemployment rate is also higher than that of the participants. On the other hand, just as the SSA (1997b, 2000) has found, the dropouts are relatively young, unhealthy and are more likely to live in big cities, but the private pension participation rate is only a little bit higher for the participants than for the dropouts. However, all of the above observations are only the results of descriptive statistics without controlling for various explanatory factors.

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[4] Participation information of private pension is about the overall household in SFACH.

[5] Spouses of salaried workers in public agency or private companies with more than five employees are qualified to be type III insurants of the national pension without paying insurance premium.

## 5. Models and estimation results

### 5.1 Dropout rate by age

Before explaining the models to be estimated, we first confirmed findings about 25-year participation period discussed in section 3. If the dropout motivation model in Figure 1 as true, the dropout rate by age will suddenly decrease for the age group of 35 to 39, that is ordinarily the maximum age group that can possibly realize the requirement of 25 years participation for receiving pension. This hypothesis can be reconfirmed in Figure 2. The dropout rate of the national pension generally declines with age, and just as expected, it declines dramatically at the point of the 35 to 39 age group. A t Test of the difference between the average dropout rate of the 20-34 age group and that of the 35-59 age group can reject the null hypothesis that no difference exists at the 1% significance level. In other words, the average dropout rates for these two age groups differ significantly.

### 5.2 Models and estimation methods

The motivation of dropout behavior from the national pension or participation behavior in private pension is estimated using the following models:

$$M_i^* = \alpha_0 + \alpha_A A_i + \alpha_U U_i + \alpha_I I_i + \alpha_F F_i + \alpha_R R_i + \alpha_H H_i + \alpha_E E_i + \alpha_S S_i + \alpha_T T_i + u_i^M$$

$$M_i = \begin{cases} 1 & if \quad M_i^* > 0 \\ 0 & otherwise \end{cases} \qquad (1)$$

$$P_i^* = \beta_0 + \beta_A A_i + \beta_U U_i + \beta_I I_i + \beta_F F_i + \beta_R R_i + \beta_H H_i + \beta_E E_i + \beta_S S_i + u_i^P$$

$$P_i = \begin{cases} 1 & if \quad P_i^* > 0 \\ 0 & otherwise \end{cases} \qquad (2)$$

$$E[u_i^M] = E[u_i^P] = 0$$

$$Var[u_i^M] = Var[u_i^P] = 1$$

$$Cov[u_i^M, u_i^P] = \rho$$

Equation (1) and (2) are defined as the “dropout choice function for the national pension” and the “participation choice function for a private pension”, respectively. Here $M_i^*$ is a latent variable, which indicates the utility difference when an individual drop out of the national pension system and utility remains in the national pension system. When the gap is positive, people choose to withdraw from the national pension system. Similarly, $P_i^*$ is also a latent variable representing the difference in utility between when an individual participates in a private pension and does not participate in a private pension. On the other hand, $M_i$ in equation (1) is the observable dependent variable which equals 1 if the individual is not participating in the national pension, and 0 otherwise. Similarly, $P_i$ equals 1 if the individual participates in a private pension system, and 0 otherwise. The independent variables include age (A), an unemployment dummy ($U$ equals 1 if the individual is employed, and 0 otherwise), household income excluding the income of the household head(I)[6], financial assets excluding private pension wealth (F), real assets (R), an health dummy (H equals 1 if unhealthy, and 0 otherwise), a gender dummy (S equals 1 if the head is a male, and 0 otherwise), an education dummy (E equals 1 if the household head has received a junior college education or more, and 0 otherwise) and metropolitan dummy ( T equals 1 if the individual lives in a city with a population of more than 150 thousand, and 0 otherwise).

As we will introduce in section 5.3, age is a proxy for the generation gap factor; the unemployment dummy, household income, financial assets and real assets are all proxy variables for the liquidity constraint factor. The health dummy is regarded as a proxy for the life expectancy factor. Other variables concerning household’s attributes such as gender, education and metropolitan dummy are also included. As we have observed from Figure 1, the choice of dropping out from the national pension system is highly correlated with the choice of private pension participation. That is to say, the errors of equations (1) and (2) should be correlated. Therefore, we have

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[6] We exclude income of the household head because it is highly related with unemployment dummy.

to estimate the bivariate probit model by seemingly unrelated regression (SUR). We define the accumulative distribution function in the likelihood function as follows:

$$\Pr(Y_1 = M_i, Y_2 = P_i) = \Phi_2(w_{i1}, w_{i2}, \rho_i^*) = \int_{-\infty}^{w_{i2}} \int_{-\infty}^{w_{i1}} \phi(z_{i1}, z_{i2}, \rho_i^*) dz_{i1} dz_{i2}$$

where

$$z_{i1} = \alpha_0 + \alpha_A A_i + \alpha_U U_i + \alpha_I I_i + \alpha_F F_i + \alpha_R R_i + \alpha_H H_i + \alpha_S S_i + \alpha_E E_i + \alpha_T T_i$$

$$z_{i2} = \beta_0 + \beta_A A_i + \beta_U U_i + \beta_I I_i + \beta_F F_i + \beta_R R_i + \beta_H H_i + \beta_S S_i + \beta_E E_i$$

$$w_{i1} = (2M_i - 1) z_{i1}$$

$$w_{i2} = (2P_i - 1) z_{i2}$$

$$\rho_i^* = (2M_i - 1)(2P_i - 1)\rho$$

$$\phi(z_{i1}, z_{i2}, \rho_i^*) = \frac{\exp[-(z_{i1}^2 + z_{i2}^2 - 2\rho_i^* z_{i1} z_{i2})/(2(1-\rho_i^{*2}))]}{2\pi(1-\rho_i^{*2})^{1/2}}$$

### *5.3 Hypothesis*

If a liquidity constraint motivated the dropout behavior of the national pension, the effects of the variables of unemployment dummy, financial assets (excluding private pension wealth) and household income (excluding household head income in equation (1) should affect the dropout behavior positively, negatively, negatively respectively. On the other hand, if the generation gap is a significant factor for pension choice, young generations should choose to drop out from the national pension and join private pensions instead. Therefore, the coefficients of the variable of Age should be negative in both equations. Although SFACH (1996) does not ask about life expectancy directly as Tsukahara (1999) did, it includes questions about the health condition of respondents. As generally unhealthy persons are expected to live less longer than healthy persons, we used the health dummy as a proxy of life expectancy. That is to say, given the hypothesis about life expectancy right, the unhealthy condition should motivate the dropout behavior of the national pension. Besides factors of life expectancy and generation gap, other evidence for the existence of "adverse selection" is that the dropouts of the national pension are more likely to join private pension than the participants do. We will verify this hypothesis by looking if the correlation coefficient $\rho$ of errors in equations (1) and (2) is significant or not.

### *5.4 results*

The estimation results are presented in Table 2-1. As the liquidity constraint hypothesis predicted, the coefficients for the variables of the unemployment dummy and financial assets are significantly positive and negative, respectively, in dropout function of public pension at the standard 10% confidence level. The liquidity constraint hypothesis is further confirmed because only the variable of financial assets is significant, and the real asset variable is not significant at all. By the way, just as expected, the household income and financial assets variables negatively affect the dropout choice of public pensions but positively affect the participation behavior of private pension. The unemployment dummy encourages drop out behavior of public pension or participation behavior of private pension.

On the other hand, the coefficient of the health dummy (proxy for the life expectancy factor) is significantly positive in the dropout choice function of the national pension. The results shows that the health dummy does not significantly affect private pension choice, which seems to be opposite to the prediction of the adverse selection hypothesis of private pension. Probably this is because the private pension companies have done something to protect themselves from "adverse selection".

The age variable (a proxy for the generation gap factor) has a significant negative effect in both functions. The errors of the two functions are also significantly and positively correlated ($\rho$ >0) which means behavior of private pension participation is positively related with the dropout behavior of public pension . All of the above results provide strong support for the "adverse selection" hypothesis of the national pension as mentioned earlier. Moreover, these results overwhelmed the judgment of the descriptive statistics of SSA (1997b, 2000) in section 4 that participants of national pension have a higher propensity to join private pension than the dropouts of national pension do. In other words, after controlling for various factors, it has been that dropouts of the national pension are actually more likely to join private pension. In addition, the coefficient of the metropolitan dummy is not significant after various specifications trying. This result also rejected the result of SSA(1995) that metropolitan residents are more likely to drop out from the national pension system. As the unemployment rate is higher in metropolitan than in small cities, the reported correlation between metropolitan residence and the dropout rate of the national pension in SSA (1995) may be misleading.

By the way, to verify the hypothesis of the 25 year participation kink[7], first we tried to add a 35-39 age dummy into the functions, but the coefficient of the age dummy is not significant at all because it is closely related with age variable (r=0.729) and the problem of multicollinearity happened. Then we replace the age variable with a set of age dummies (see Table 2-2). Although the magnitude of the coefficients declines with age apparently in the dropout function, the gap is not statistically significant when compared to the oldest age group (55-59). The size of the coefficient is quite lower for the age group of 35 to 39 than for the younger groups, but the coefficients of the age dummies are not statistically significant.

Table3 includes the marginal effect of all independent variables on the participation status of private pension. According to the estimates, the dropout probability of the national pension will increase: a) 0.24% (private pension insurants) and 0.41% (non private pension insurants) for a one year fall in age, b) 8.2% and 15.7% for unhealthy individuals, c) 5.1% and 11.1% for the unemployed, and d) 0.55% and 1.1% for every 1 million Yen decrease in the amount of financial assets.

Although both the effect of liquidity constraint and the effect of adverse selection are

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[7] The estimation results of age dummies are newly included into this paper. Besides, this paper updated the earlier version by reorganizing and revising the content to make it easier to be

confirmed, which effect is relatively larger? To investigate this problem, we exclude the proxies of liquidity factor (unemployment dummy, household income and financial assets) from the dropout choice function of the national pension and define the log likelihood (lnL) of the new function as “lnL of adverse selection effect”. Similarly, we drop the proxies of the adverse selection factor (Age and health dummy) and define log likelihood of the new function as “lnL of liquidity constraint effect”. However, when independent variables of the functions are not orthogonal, the estimations of Table 2 will be problematic. Therefore, our conclusions here should be given a more careful consideration if possible.

As we can see from the Table 3, the log likelihood for the full model, the liquidity constraint factor model and adverse selection factor model are –437.3, -456.8 and –444.2 respectively, which means that the power of adverse selection factor in explaining dropout behavior is bigger than that of the liquidity factor. In other words, the effect of adverse selection factor on the national pension dropout decision is relatively large.

## *6. Conclusions*

Based upon the above findings, some policy implications can easily be drawn. First, the pitfall of “25 years participation” of the national pension should be abolished. Just as Figure 2 has pointed out, insurants will be aggregated around the 25 years pitfall of participation. If people who prefer less than 25 years participation could choose their future pension benefit by adjusting their participation period freely, not only would their utility be improved, but also the national pension dropout rate would decline. Second, the existence of a liquidity constraint indicates that policies such as the expansion of insurance fee waiver or optional participation period should be considered.

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understood.

Finally, policies aimed at alleviating adverse selection problem should be considered. According to the White Book of Pension 1999, the Public Welfare Agency has proposed the following strategies: a) sending a participation recommendation letter to the targeted insurants of the national pension system, and sending a pension book to those who do not respond if necessary, a way we call a “recognition application”. b) because about 70% of dropouts are joining the national medical care system, the recommendation letter or recognition application can be performed based on the register for the national medical care system, and c) grasping the information of dropouts by creating a basic pension number. However, all of these methods do not work so well according to the investigation of the Administration Inspection Bureau of General Affairs Agency (1998). The main reason for this failure, as Takayama (1998) has discussed, is that the national pension insurance fee is collected by the “social security method”. Under the social security method, it is too costly to master the information of dropouts or to collect the insurance premium obligingly. To save administration costs, policies like strengthening the punishment rules or collecting insurance premium by “tax method” should be considered. In addition to compulsory collection or tax collection of insurance premium, policies alleviating inter-generation inequality in pension benefits should also be performed as to improve the public’s trust in the public pension. The best way to alleviate inter-generation inequality is to raise the current insurance tax rate and fix it thereafter (Hatta & Oguchi 1999).

Propositions such as abandoning the system of adjusting benefit amount with the participation period can be found in Eckstein et al (1985). In other words, they suggest requiring all members to pay the same amount of insurance tax and to join the national pension system for the same length option, such as 40 years, and then receive the same amount of benefit after retirement. Eckstein et al (1985) argue that a public pension system with the same amount of insurance premium and benefit will lead to a Pareto Improvement to all of the members. The main logic of this argument is as follows: in a perfect private pension market with adverse selection bias, high risk individuals will face higher insurance premium and low risk individuals will have narrower range of insurance to choose than when there exists some public pension. The introduction of public pension will not only lower the insurance premium of high risky persons but also enlarge the range of insurance for the people of low risk, therefore all social members will enjoy a Pareto Improvement. The above model about public pension should be efficient if a proper participation range can be set. It could also work poorly if the participation range is set too long or too short. However, the issue of whether the 40 years participation rule is a proper range remains a puzzle, and is left as a future research topic.

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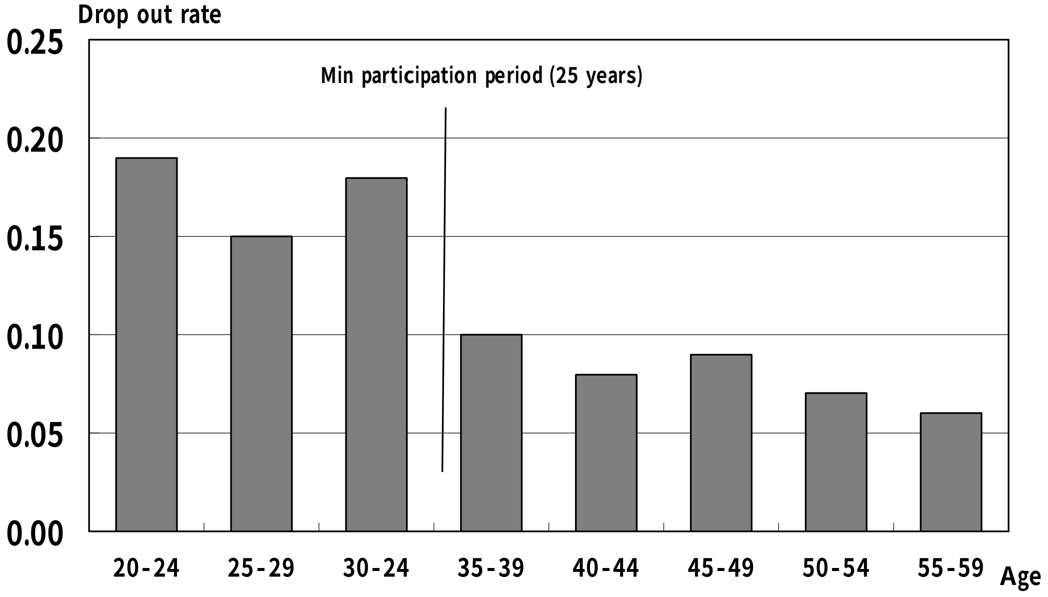
## Table 1 Descriptive Statistics

| | Participants of National Pension | | | | Seceders of National Pension | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.E. | Min | Max | Mean | S.E. | Min | Max |
| Private Pension Participant | **0.18** | 0.38 | 0 | 1 | **0.17** | 0.38 | 0 | 1 |
| Age | **45.4** | 10.0 | 20.0 | 59.0 | **41.0** | 11.4 | 20.0 | 59.0 |
| Unemployed | **0.07** | 0.26 | 0 | 1 | **0.20** | 0.40 | 0 | 1 |
| Total Household Income | **441** | 541 | 0 | 4,740 | **298** | 290 | 0 | 1,300 |
| Income of Head | **323** | 407 | 0 | 3,130 | **242** | 233 | 0 | 1,000 |
| Excluding Head Income | **124** | 233 | 0 | 1,980 | **56** | 125 | 0 | 640 |
| Financial Assets (FA) | **774** | 1,847 | 0 | 25,700 | **218** | 360 | 0 | 1,510 |
| FA Excluding Private Pension Wealth | **729** | 1,807 | 0 | 25,650 | **206** | 338 | 0 | 1,510 |
| Real Assets | **1,497** | 4,837 | 0 | 72,300 | **519** | 2,025 | 0 | 12,000 |
| Unhealthy | **0.05** | 0.22 | 0 | 1 | **0.17** | 0.38 | 0 | 1 |
| Education | **0.20** | 0.40 | 0 | 1 | **0.15** | 0.36 | 0 | 1 |
| Gender | **0.89** | 0.32 | 0 | 1 | **0.85** | 0.36 | 0 | 1 |
| metropolis | **0.27** | 0.45 | 0 | 1 | **0.33** | 0.48 | 0 | 1 |

Note: Total sample size is 611 with 551 participants and 60 seceders. Variables of "Private Pension participants", "Unemployed", "Unhealthy" are dummies which equal 1 if so, otherwise they equal to 0. "Gender" equals to 1 if male, 0 if female. "Metropolis" equals to 1 if living in cities with more than 150 thoushands, otherwise 0. "Education" equal to 1 if the head has more than university education, otherwise 0. All data about income or assets are expressed in a unit of 10 thousands Yen.

Figure 2 Dropout Rate of National Pension by Age



Note: Dropout rates for age groups of 20-34 and 35-59 are 0.175 (0.382) and 0.079 (0.271) respectively (S.E. in the parenthesis). Test for the difference of means results in a t value of 3.175, which can reject the hypothesis that average dropout rates are the same for the two age groups at 1% significant level.

# Chapter 2

# Precautionary Saving and Earnings Uncertainty in Japan: A Household-Level Analysis[*]

*Abstract*

This paper improves upon the methodology of Dardanoni (1991) and applies it to household-level data from a Japanese Government survey in order to analyze the impact and importance of precautionary saving arising from earnings uncertainty. In particular, the paper (1) investigates what attributes affect earnings uncertainty and uses that information to develop a measure of earnings uncertainty, (2) tests the simple prediction of the precautionary saving model that earnings uncertainty should influence household consumption and saving, and (3) calculates the share of precautionary saving in total household saving.

The paper contributes to the literature on precautionary saving in the following respects: (1) it is the first attempt to analyze the impact of earnings uncertainty on the consumption and saving of Japanese households using household-level data, (2) it improves upon Dardanoni (1991) by employing a more complete model, by conducting a careful analysis of what attributes affect earnings uncertainty before deciding which grouping variables to use, by using not only grouped data but also household-level data in the estimations, and by estimating the consumption function not only for the full sample but also for young and old households separately, and (3) it estimates the share of precautionary saving in total household saving in Japan.

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Our major results can be summarized as follows: (1) occupation, age, and educational attainment significantly affect earnings uncertainty, (2) earnings uncertainty has a significant impact on household consumption and saving, (3) precautionary saving arising from earnings uncertainty comprises 8.303% to 12.579% of total household saving, and (4) the prediction of Carroll and Summers's (1991) buffer stock saving hypothesis that young households will be more likely to save for precautionary purposes than older households is confirmed.

## *1. Introduction*

Japan is currently experiencing the longest recession since World War II. When, how, and whether this recession will end remains a crucial public policy issue and academic puzzle. Compared to the extremely strong consumption demand of American households and the unprecedented economic boom in the U.S., Japanese households behave as though they are reluctant to consume, and their saving rate is much higher than that of Americans. Excessive household saving is regarded as one of the main negative factors for the recovery of the Japanese economy. Although Japan's high household saving rate is determined jointly by a large number of factors (Horioka, 1990), the importance of precautionary saving has been regarded as one of the most important ones, especially since the collapse of Japan's bubble economy (Horioka and Watanabe, 1997; Hahm, 1999; and Horioka, Fujisaki, Watanabe, and Kouno, 2000). Even so, few empirical analyses of the precautionary saving behavior of Japanese households have been conducted. The purpose of the present paper is to conduct just such an analysis using household-level data from a Japanese Government survey.

The importance of precautionary saving cannot be emphasized enough. Several researchers (Skinner, 1988; Aiyagari, 1994) have argued that precautionary saving behavior has important macroeconomic implications. First, the presence of precautionary saving substantially alters optimal government policies: government policies that are neutral in the absence of precautionary saving may have a substantial impact on consumer behavior in the presence of precautionary saving. For example, if uncertainty affects consumer behavior, government insurance programs and tax policies may reduce individual risks and thereby increase welfare (Zeldes, 1989). Second, other important issues such as the effect of increased tax progressivity on saving and the efficient taxation of saving depend on whether households engage in precautionary saving. In terms of microeconomic implications, precautionary saving can explain a number of consumption ‘puzzles,’ such as the excess smoothness of household consumption, the growth of saving even in the presence of low real interest rates, and the slow rate of wealth decumulation of the elderly.

Using data from the 1983 Survey of Consumer Finances (SCF), Carroll (1996) found that 43% of respondents reported being prepared for emergencies as being their most important reason for saving, whereas the proportion of respondents who gave preparing for retirement as their most important saving motive was only 15% (see Horioka and Watanabe (1997) and Horioka., Fujisaki, Watanabe, and Kouno (2000) for similar data on Japan). The former motive is a precautionary motive, while the latter motive is a retirement motive, which is traditionally regarded as evidence in favor of the certainty equivalence Life Cycle/ Permanent Income Hypothesis (LC/PIH). While the certainty equivalence LC/PIH is widely employed as a framework for empirical analysis at both the aggregate and household levels, the empirical evidence thereon is mixed. Some studies (e.g. Blundell, 1988; King, 1985) conclude that only part of the variation in consumption can be explained by life cycle behavior and that there are several phenomena (such as the excess saving of the aged and the excess sensitivity of consumption to current income) that cannot be explained merely by the certainty equivalence LC/PIH. Skinner (1988) is one of the most influential papers on the effect of uncertainty on consumer behavior. He finds that saving that arises as a precaution against future uncertainty is a significant proportion (more than one-half under certain assumptions) of total life cycle saving. Carroll and Summers (1991) suggest that consumers do not save for retirement over most of their working lives, say until roughly age 45 or 50, and thus that the certainty equivalence LC/PIH can explain consumer behavior only between about age 50 and retirement.

The idea that people engage in precautionary saving dates back to Friedman (1957). Later studies by Leland (1968), Sandmo (1970), and Dreze and Modigliani (1972) showed the theoretical conditions about preferences under which an increase in uninsurable risk leads to higher saving. Recent research has further sharpened the theory of precautionary saving. Zeldes (1989) extended the two-period framework used by earlier authors to the multi-period case and established that the amount of precautionary saving increases in response to an increase in the variance of shocks to the income-generating process and in their degree of persistence. However, the empirical results concerning the importance of precautionary saving are inconclusive. Guiso (1992) uses a self-reported measure[1] of the subjective uncertainty of future earnings and finds that, on average, precautionary saving accounted for only 2% of Italian households' net worth in 1990. Thus, earnings uncertainty fails to explain a significant fraction of saving and wealth accumulation among Italian households. Using the Family, Member, and Detailed Expenditure files of the CEX for the 1980-93 period, Parker (1999) also finds no evidence that precautionary saving is responsible for the failure of consumption smoothing to hold.

There has been very little empirical research done on precautionary saving in Japan. Ginama (1988) presents time series estimates of the ratio of precautionary saving to total personal saving in the U.S. and Japan. He finds that precautionary saving can explain Japan's relatively high saving rate to some extent but that the precautionary

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[1] Every income recipient was asked to assign probabilities to various ranges of inflation and percentage increases in nominal earnings one year from now. These two marginal distributions are then used to calculate the subjective uncertainty of real earnings.

saving motive of Japanese households was significant only during the period of the first oil crisis (1974-1976). For example, he estimates the share of precautionary saving to have been 5.81% in 1974, 4.13% in 1975, 2.57% in 1976, and less than 0.5% thereafter. Similarly, using time series data for the 1971-87 period from the Survey of Consumption Trends in Japan, Ogawa (1991) investigates the importance of precautionary saving by using the variance of income growth rate expectations of Japanese households as a proxy for the degree of income uncertainty. Like Ginama, he finds that precautionary saving comprised a significant share of worker households' saving only at the time of the first oil crisis. For example, he estimates the share of precautionary saving to have been 10.53% in 1974, 10.62% in 1975, 7.82% in 1976, and much lower thereafter. However, he finds precautionary saving to have been important throughout the period of analysis in the case of farmers' households.

Most previous analyses of precautionary saving use either simulation techniques (Skinner, 1988; Zeldes, 1989) or a measure of earnings uncertainty that is calculated from time series data (Ginama, 1988; Ogawa, 1991; Hahm, 1999), but simulation analyses have been criticized because the results depend on their assumptions about risk aversion preferences and the income-generating process. Other studies use self-reported information to construct a subjective measure of earning uncertainty (Carroll, 1996; Guiso, 1992), but most surveys do not collect such data. While useful, all three approaches have their drawbacks.

Surprisingly, there have been few studies that have used a measure of earnings uncertainty that is calculated from cross section data with the sole exception of Dardanoni (1991), and there have been no such studies for Japan, but measures of earnings uncertainty based on cross section data are valuable as a possible substitute for the two kinds of measures discussed above. For one thing, cross section data is much more readily available than panel data or the self-reported measures discussed above, and thus measures of earnings uncertainty that are calculated from cross section data would undoubtedly be widely used if available.

It is Dardanoni (1991) who makes the first attempt to estimate the magnitude of precautionary saving at the household level. Using cross-section data from the 1984 UK Family Expenditure Survey, he derives and tests a closed form solution for present consumption as a function of current and expected economic variables and finds that precautionary saving comprises a significant proportion of total household saving.

The present paper improves upon the methodology of Dardanoni (1991) and applies it to household-level data from a Japanese Government survey in order to analyze the impact and importance of precautionary saving arising from earnings uncertainty. In particular, the paper (1) investigates what attributes affect earnings uncertainty and uses that information to develop a measure of earnings uncertainty, (2) tests the simple prediction of the precautionary saving model that earnings uncertainty should influence household consumption and saving, and (3) calculates the share of precautionary saving in total household saving.

The paper contributes to the literature on precautionary saving in the following respects: (1) it is the first attempt to analyze the impact of earnings uncertainty on the consumption and saving of Japanese households using household-level data, (2) it improves upon Dardanoni (1991) by employing a more complete model, by conducting a careful analysis of what attributes affect earnings uncertainty before deciding which grouping variables to use, by using not only grouped data but also household-level data in the estimations, and by estimating the consumption function not only for the full sample but also for young and old households separately, and (3) it estimates the share of precautionary saving in total household saving in Japan.

The detailed plan of this paper is as follows: The data used in the analysis are described in section 2, the basic model and research strategy are set out in section 3, the main results are presented in section 4, and our conclusions are summarized in section 5.

Our major results can be summarized as follows:
(1) occupation, age, and educational attainment significantly affect earnings uncertainty, (2) earnings uncertainty has a significant impact on household consumption and saving, (3) precautionary saving arising from earnings uncertainty comprises at least 5.6% of total household saving, and (4) the prediction of Carroll and Summers's (1991) buffer stock saving hypothesis that young households will be more likely to save for precautionary purposes than older households is confirmed.

## *2. Sample selection*

This study uses data on 2,441 Japanese households taken from the 1996 Survey on the Financial Asset Choice of Households (SFACH), a survey of 3,942 households whose heads are 20 or older (including single households) from throughout Japan. The number of observations was reduced to 2,514 in four stages. First, we excluded all households headed by a female (n=357) regardless of whether she is single or married. A substantial fraction of such households are widows whose permanent income is determined primarily by the lifetime earnings of the deceased husband on whom no information was available. Households headed by a married female are mainly poorer households and their average income is only about half that of all households. The permanent income and saving behavior of young single female households may depend on her future husband, information on whom is not yet available. Next, households headed by students (n=16), unemployed (n=52) or part time workers (n=24) were also excluded because most of students have no income yet and the income profile of part time worker is too hard to be predicted. We also excluded households that reported negative disposable income (n=3). Finally, we dropped all households with a head who is older than 60 because the labor income of retired household heads will be zero or extremely low and will generally not reflect their pre-retirement income (n=1,050). Because our main objective is to investigate whether people save for life cycle or precautionary motives, we focus on the choices of working households. A more detailed discussion about the data will be found in Appendix I.

## *3. Models*

### 3-1 Conditions for precautionary saving (Leland, 1968)

Leland (1968) derived the theoretical conditions under which the precautionary demand for saving is positive. He assumes that the consumers have no initial assets and that they attempt to maximize expected utility over two periods while facing earning uncertainty in the second period. Mathematically, the problem is expressed as: Maximize $E[U(C_1, C_2)]$ subject to

$$C_1 = (1-s)Y_1 \qquad s<1$$
$$C_2 = Y_2 + (1+r)sY_1$$
$$E(Y_2) = Y_2^*$$
$$E(Y_2 - Y_2^*)^2 = \sigma^2$$

where r is the real interest rate and s is the saving rate with an upper limit of 1 and no exact lower limit. $Y_1$ is total labor income (fixed) in period 1, and $Y_2$ is total labor income (random) in period 2. Setting the derivative of $E[U(C_1, C_2)]$ with respect to s equal to zero yields the following first order condition:

$$\partial\{E[U(C_1, C_2)]\}/\partial s = E(U_1)*(-Y_1) + E(U_2)*(1+r)Y_1 = 0$$
$$\Rightarrow \partial E(U)/\partial s = (1+r)E(U_2) - E(U_1) = 0$$

The right-hand side of the above equation represents the consumption gap between periods 1 and 2. Therefore, in order for precautionary saving to be positive, earnings uncertainty must reduce this gap by increasing saving above its initial level. Mathematically, the condition for the precautionary demand for saving to be positive is as follows:

$$\frac{d^2[E(U)]}{d^2 s} = \frac{d[(1+r)E(U_2) - E(U_1)]}{ds} < 0$$

### *3-2 Empirical Model*

### *3-2-1 The Precautionary Saving Model of Dardanoni*

This model reflects the theory of optimal consumption under income uncertainty and is plausible in a stochastic setting as well. Therefore, we can call it an extended LC/PI model with precautionary saving. This paper provides a more detailed derivation (see Appendix I) and employs clearer notation than Dardanoni (1991). Moreover, it employs an improved version of Dardanoni model in the estimation.

As Dardanoni (1991) has done, we use a stationary infinite horizon model in which the consumer maximizes the expected value of the sum of discounted utilities:

$$\max E\sum_{t=1}^{T} B^{t-1} U(C_t) \qquad \text{s.t.}$$

$$H_{t+1} = R(H_t - C_t) + Y_{t+1} = R(H_t - C_t) + Y_t + e_{t+1}$$ [2]

E denotes the expectation taken with respect to the stochastic income stream, 0<B<1 is the time discount factor, and C is consumption. R [3] equals "1+r", where r is the real interest rate. $H_{t+1}$ [4] is the amount of total wealth holdings in period t+1 and includes not only leftover non-human assets from period t ($W_{t+1}$) but also labor income in period t+1 ($Y_{t+1}$). The stochastic income stream is assumed to follow a random walk, $Y_{t+1} = Y_t + e_{t+1}$, where $e_1$, $e_2$,... are independently and identically distributed random variables with zero mean and a known distribution. As the maximum value function and the optimal strategy are time-independent, we can drop the time subscripts to avoid notational clutter. Some studies (e.g. Merton, 1971; Hey, 1984)

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[2] This income constraint is essentially the same as that of Takayama et al. (1992)-- $W_{t+1} = R_t(W_t + Y_t - C_t)$, where W refers only to non-human assets.

[3] Dardanoni (1991) uses r instead of R.

[4] Dardanoni (1991) uses W instead of H.

show that a closed-form solution may be obtained by assuming that the utility function displays constant relative risk aversion and that, in such a case, the optimal consumption plan is linear in total wealth ($C^*(H) = c_0 + c_1 H$) and depends on what stochastic assumptions are made about the distribution of future income. Employing the utility function U(C)=-exp(-kC), where k is the risk-aversion parameter, we can obtain a closed-form solution for optimal consumption (see Appendix I):

$$C^*(H) = c_0 + c_1 H = Y/R - \frac{\log(RB)}{kr} - krV/2R^2 + c_1 H$$

$$\Downarrow$$

$$\Rightarrow \qquad C^*(H) = c_0 + c_1 H = P_t - \frac{\log(RB)}{kr} - (kr/2R^2)V \qquad (5)^5$$

where we assume that $e_{+1}$ is normally distributed with variance V, and

$P_t$ =the annuity value of total wealth $= \frac{r}{R} E(H + Y_{+1}/R + Y_{+2}/R^3 + \ldots + Y_{+n}/R^n + \ldots)$

The first term $P_t$, which equals the annuity value of the sum of initial wealth and the present value of expected future income, is what is predicted by the LC/PIH. $P_t$ can also be rewritten as $P_t = Y^p + \frac{1}{T-t+1} W_t$, where $Y^p$ is permanent labor income, W is non-human assets which includes real assets (RA), financial assets (FA) and social security wealth (SSW), and T is the year of death. The second term is a risk aversion factor (k), which will usually have a negative impact on household consumption. The third term is a risk premium, which represents the necessity of precautionary savings. Equation (5) predicts that, in the presence of income risk, precautionary saving will be a function of the annuity value of total wealth, risk aversion and the variance of shocks to labor income. Thus, consumption is jointly decided by the following set of

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[5] This equation is essentially the same as the solution of Blanchard & Mankiw (1988): $C_t = (1/(T-t+1))W_t + Y_t - (\gamma(T-t)/4)V$, where T is the time of death and $\gamma$ is the coefficient of prudence. For simplicity, $\gamma$ is assumed to be 1 in our estimation.

variables:

$$C = f(Y^p, RA, FA, SSW, V, k)$$

One of the main difficulties in estimating the above consumption function is the unobservable nature of almost all of the variables it involves. As our data set is not panel data, we do not have the information needed to estimate the future earnings variance of each household. However, we can eliminate this problem by using a proxy for individual labor income uncertainty, as done by Dardanoni (1991). By so doing, we can easily measure households' earnings uncertainty using cross-section data (refer to the detailed explanation in section 3-3). Probably because of data limitations, Dardanoni (1991) incorporated the variables RA, FA, SSW and k into the intercept term. However, this paper merges only k with the constant term and RA, FA and SSW are included explicitly in the consumption function. Because of the high correlation between RA and FA, however, we employ their sum (ASSET) in the actual estimation.

C= f ($Y^p$,ASSET(RA, FA) , SSW, V) [6] (6)

*3-2-2 Consumption Function*

There are at least two ways to estimate consumption function (6). The first way is to use group averages as Dardanoni (1991) does in his research. He simply divided the sample into dozens of homogeneous cells and employed the income variance within each cell as an index of earnings uncertainty for each household within that cell. The consumption function can therefore be expressed as:

$$\overline{C} = a_0 + a_1\overline{Y} + a_2 AS\overline{S}ET + a_3 S\overline{S}W + a_4 V(\overline{Y}) + u \qquad (6\text{-}1)$$

where $\overline{C}$ is the average consumption of households in each cell, AS$\overline{S}$ET is the average amount of real assets (RA) and financial assets (FA) in each cell, and $S\overline{S}W$ is average social security wealth in each cell. Average disposable income within each

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[6] The model Dardanoni (1991) employed in his estimation is: C=f($Y^p$, V).

cell ($\overline{Y}$) is used as a proxy for permanent labor income of households in that cell. $V(\overline{Y})$ is the variance of labor income among households within each cell and is used as a proxy for the time series variance of permanent income for individual households.

The advantage of this method is that the calculations are simple. The weakness of this method is that by replacing individual data with group averages, important information is discarded.

The second way to estimate the consumption function is to use individual values for all of the variables except for earnings uncertainty (V):

$$C = a_0 + a_1\hat{Y}^p + a_2 ASSET + a_3 SSW + a_4 V(\overline{Y}) + v \qquad \text{(6-2)}$$

The advantage of this method is that individual data retain more information than grouped data.

In the case of both equations (6-1) and (6-2), a strict fulfillment of precautionary saving theory requires that:

$$a_0 > 0, \quad a_1 > 0, \quad a_2 > 0, \quad a_3 > 0, \quad a_4 < 0$$

Because the constant term $a_0$ picks up primarily the reverse (positive) effect of the risk aversion factor k, its sign should be positive. The coefficients of permanent income ($a_1$), ASSET ($a_2$), and SSW ($a_3$) should all be positive because the more permanent income, ASSET, or SSW a household owns, the more it should consume. In both equations, we should pay particular attention to whether or not $a_4$<0 in order to see if there is a positive effect of the precautionary motive on saving.

We estimate the permanent labor income ($\hat{Y}^p$) of household heads and their spouses from their earnings profiles using such explanatory variables as age, education, occupation, health condition, and place of residence (Tables 2-1, 2-2, 2-3, 2-4). The income profile of full-time salaried workers is estimated separately from that of other occupations because we would expect full-time salaried workers to show a more pronounced hump-shaped age-earnings profile, with earnings reaching their peak at about age 50 or 55 and then declining. As a result, we included the square of the individual's age as an explanatory variable in the earnings profile of full-time salaried workers.

### *3-3 Measurement of earnings uncertainty*

Using cross section data for Britain, Dardanoni (1991) estimated income variances by grouping the sample into dozens of cells whose heads belong to the same industry, economic position, and skill level. Income variance within each cell is regarded as the approximate V for each member in that cell. Therefore, households within each cell must be as homogenous as possible. However, Dardanoni (1991) never provided any justification for assuming that industry, economic position, and skill level are the best criteria for grouping observations, nor did he show that income variances differ significantly among cells.

This paper borrows the method of Dardanoni (1991) but also proposes some simple ways of showing that our measure of earnings uncertainty is reliable. In other words, we use regression analysis to identify the factors that affect the homogeneity or heterogeneity of households with respect to labor income (Y), assets, social security wealth (SSW), and income variance (V). Moreover, we perform a further test to see whether the estimated income variances vary significantly among cells.

#### *3-3-1 Grouping the data*

To keep households within each group as homogeneous as possible in the levels of Y, assets, SSW and V, we must select criteria that are most likely to influence the above household characteristics.

Attributes that affect household earnings uncertainty were selected in four stages.

In the first stage, the labor income of the household head was regressed on various potentially important factors (tables 2-1, 2-2). According to the results, the age, educational attainment, and health condition of the household head and the household's place of residence seem to significantly affect the labor income of the household head. Regressing these variables on asset and SSW shows that they are all or partly significant (tables 3-1, 3-2). Moreover, as we stated before, the occupation of the household head (for example, whether he or she is a salaried worker or not) will also influence the household head's labor income. In the second stage, we employed these five attributes (the age, educational attainment, health condition, and occupation of the household head and the household's place of residence) as criteria when grouping the data. In order to insure that group averages are reliable, all cells containing less than five households were eliminated from the sample. This resulted in a total of 63 groups, the biggest of which contains 103 households. In the third stage, we investigated whether or not the five attributes we selected have a significant impact on household income variance. As we can easily see from table 4, income variance differs significantly by the occupation, age, and educational attainment of the household head but does not differ significantly by the household head's health condition or the household's place of residence. Therefore, in the fourth stage, we grouped households by the occupation[7], age, and educational attainment of the household head only (table 5). There were 56 cells with five or more observations. The largest cell, which contains households with a head who is in his 40s, college-educated, and working for a large private company, contains 129 observations.

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[7] We include self-employee, fisherman and farmer in the same professional category after finding the independent profession dummy of fisher and farmer does not affect the value of income variance significantly. Although income variance within this professional category may still vary significantly inside, we group samples with profession, education and age together and therefore greatly reduced the degree of income variance within groups.

The occupation variable classifies each household according to whether the head is a full-time salaried worker in a small private company, a full-time salaried worker in a large private company[8], a full-time salaried worker in a government agency or other organization, or a self employee or a farmer, or a fisherman. It is likely that farmers, fisherman, and self-employee face more earnings uncertainty than salaried workers do and that employees of small private companies face more earnings uncertainty than salaried workers of large private companies do because their jobs are generally less stable in Japan. The second variable classifies each household according to the age group of the household head (20-29, 30-39, 40-49, and 50-59). The relatively high unemployment rate of young and old workers suggests that they may face more earnings uncertainty than middle aged workers. The last variable pertains to the educational attainment of the household head (whether the head is a junior high school, senior high school, junior college or college graduate). The higher one's educational attainment, the less earnings uncertainty one is likely to face in the future because of the effect of human capital accumulation. Each household can therefore be classified into cells that contain only households with a head with the same occupation, age and educational attainment. Households in the same cell are assumed to face the same level of earnings uncertainty, and households in different cells are assumed to face different levels of earnings uncertainty.

### *3-3-2 Income variance— Earnings uncertainty*

Dardanoni (1991) suggests employing the income variance within each homogeneous cell as a proxy for the earnings uncertainty of all households in that cell. This index can be expressed mathematically as:

$$V(\overline{Y}^{D}) = \frac{\sum_{i=1}^{n} (Y_i - \overline{Y})^2}{n-1}$$

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[8] Private companies are divided into two categories—small companies with less than 100 employees and large companies with 100 or more employees.

However, because we wanted to take account of variance in the labor income of the household head as well as of variance in the labor income of the household head's spouse, we actually calculated income variance in a more complicated way—namely,

$$V(\overline{Y}^{D}) = V(\overline{Y}_h) + V(\overline{Y}_s) + 2\operatorname{cov}(\overline{Y}_h, \overline{Y}_s)$$

$$= \sum_{i=1}^{n}(Y_{ih} - \overline{Y}_h)^2/(n-1) + \sum_{i=1}^{n}(Y_{is} - \overline{Y}_s)^2/(n-1) + 2*\{\sum_{i=1}^{n}(Y_{ih} - \overline{Y}_h)(Y_{is} - \overline{Y}_s)\}/(n-1),$$

where n is the number of observations in a specific cell, subscript h denotes "household head" and subscript s denotes "spouse." As we have all of the necessary information, the joint income variance of the household head and his spouse can easily be calculated and is used in our estimations. However, to keep our analysis as simple as possible, we ignore the cohort effect on permanent income.

## 4. *Empirical Results*

It is still not known whether the empirical failure of the LC/PIH is due to earnings uncertainty or to other factors such as liquidity constraints or bequest motives, and thus testing for the existence and magnitude of the precautionary saving motive is of crucial importance. This paper tests for the validity of the precautionary saving model by estimating equations (6-1) and (6-2):

$$\overline{C} = a_0 + a_1\overline{Y} + a_2AS\overline{S}ET + a_3S\overline{S}W + a_4V(\overline{Y}) + u \qquad (6\text{-}1)$$

$$C = a_0 + a_1\hat{Y}^{p} + a_2ASSET + a_3SSW + a_4V(\overline{Y}) + v \qquad (6\text{-}2)$$

As we discussed before, the precautionary saving model requires that

$$a_0>0,\ a_1>0,\ a_2>0,\ a_3>0,\ a_4<0$$

We estimated both equations using weighted least squares (WLS) because the use of grouped data may cause the variance of the error term to be inversely proportional to group size and because the use of household-level data also typically leads to heteroscedasticity.

Table 6-1 shows the WLS estimates of equation (6-1). The consumption functions of all households, older households (households with a head aged 50 or over), and younger households (household with a head aged 49 or younger) are estimated separately. Although the magnitude of each coefficient varies from case to case, we find that the coefficients of all of the explanatory variables are statistically significant and fully satisfy the predictions the precautionary saving model with the exception of the coefficient of SSW. For example, in case I (all households), the estimated coefficient of $\overline{Y}$ is 0.1749, that of $AS\overline{S}ET$ is 0.0164, that of $V(\overline{Y}^{D})$ is -0.000033, and the intercept is 229.3873. Dropping $V(\overline{Y}^{D})$ from equation 6-1 only slightly lowers its adjusted R-squared from 0.7575 to 0.7506. This suggests that the effect of the precautionary motive on household consumption/saving may not be as strong as we had expected. In sum, the estimation results based on grouped data suggest that although earnings uncertainty has a significant negative impact on the consumption of Japanese households, the magnitude of its effect is not clear.

Table 6-2 presents the estimation results of the precautionary saving model based on household-level data (equation 6-2). Due to the habitual tendency of heteroskedasticity to be present in consumption functions based on household-level data, we chose to estimate equation 6-2 using Feasible Generalized Least Squares (FGLS). The coefficients of all variables show the signs predicted by the precautionary saving model and are statistically significant in almost all cases. For example, in the case of all households, the estimated coefficient of Y is 0.1321, that of ASSET is -0.0000125, that of SSW is 0.01955, that of $V(\overline{Y}^{D})$ is -0.0001883, and the intercept is 1.9696 (case I in table 6-2). Dropping $V(\overline{Y}^{D})$ from equation 6-2 also slightly lowers its adjusted R-squared from 0.3352 to 0.3302. This confirms what we found on the grouped data that the effect of precautionary motive on household saving might be somewhat low.

Tables 6-3 and 6-4 presented the estimation results of the consumption functions when adding some dummy variables about household’s attributes. Profession, education, age, health condition of household head, my home ownership, number of kids and marriage status are also possible variables that could possibly affect the consumption preference of households. Besides, ratio of risky assets among total financial assets represents the risk aversion degree of households. The main conclusions about main variables such as income variance and social security wealth are totally in coincident with what we found in tables 6-1 and 6-2. Consumption of younger household seems to be positively related with its home ownership, number of kids and marriage status. For the consumption of older household, health condition is one of the important determinants. In other words, households with healthy head have a bigger consumption given other conditions unchanged. In addition, the higher ratio of risky assets, the more income households engaged in saving instead of consumption. Compared to the self-employee, fisher or farmer, employees of public agency and private companies are less inclined to consume. Age and education are positively related with consumption.

Finally, we verify the magnitude of precautionary saving by calculating what our estimation results imply about the share of precautionary saving in total household saving. We can calculate the share of precautionary saving ( $\lambda$ ) from $a_4$, the estimated coefficient of $V(\overline{Y}^D)$, as follows:

$$\lambda = \frac{\sum_{i=1}^{n} PS_i}{\sum_{i=1}^{n} S} = \frac{\sum_{i=1}^{n} [-a_4 * V(\overline{Y}^D)]}{\sum_{i=1}^{n} (Y - C)} \qquad \text{n=1,2,...2441}$$

$\lambda$ equals 0.0830287 in case I of equation 6-2 ( $a_4$=-0.0001882), which means that precautionary saving comprises about 8.303 percent of total household saving. While for the estimation of all households in table 6-3, $\lambda$ equals 0.1257921 where the coefficient of income variance is -0.0002712. Moreover, the impact of $V(\overline{Y}^D)$ on consumption is statistically significant in the case of all households (case I) and younger households (case VI) but not significant in the case of old households (case IV). This finding combined with the finding about older households based on grouped data is in accordance with the hypothesis of Carroll and Summers (1991) that young households are more likely to save for precautionary purposes and that old households save primarily for retirement.

## *5. Conclusion*

This paper uses household-level data from a Japanese Government survey to analyze the existence of precautionary saving as a potential source of cross-household differences in consumption and saving and to test the hypothesis that households with greater earnings uncertainty have systematically higher saving rates.

Our estimation results show that the precautionary saving model should be fully accepted and that income uncertainty has a statistically significant impact on Japanese household saving. Although there still remains some uncertainty about the magnitude of the impact of precautionary saving on household saving, we find that precautionary saving may account for 8.303% to 12.579% of total Japanese household saving, and this finding is broadly consistent with the findings of Ginama (1988) and Ogawa (1991). The 8.303% to 12.579% figure may seem low, but it must the borne in mind that, earnings uncertainty is only one of numerous uncertainties faced by households and that the total amount of precautionary saving attributable to all sources of uncertainty could well be much higher. Indeed, survey respondents in Japan and elsewhere consistently indicate that saving for illness and other emergencies is one of their main reasons for saving. For example, according to the 1994 “Survey on the Financial Asset Choice of Households,” conducted by the Japanese Ministry of Posts and Telecommunications, well over half of all Japanese households report that they are saving for precautionary motives and precautionary saving comprises a full 8.303% to 12.579% of their total saving (see Horioka and Watanabe, 1997). Similarly, according to the 1996 “Comparative Survey of Savings in Japan and the United States,” also conducted by the Japanese Ministry of Posts and Telecommunications, precautionary saving comprises a full 62% and 31% of total household saving in the United States and Japan, respectively (see Horioka, Fujisaki, Watanabe, and Kouno (2000)). Finally, the prediction of Carroll and Summers (1991) that precautionary saving is more important for younger households than for older households is also supported by the results based on household-level data.

Turning finally to policy implications, our finding that precautionary saving arising from earnings uncertainty is of some importance implies that policies aimed at alleviating earnings uncertainty (such as reform of the unemployment insurance and employment systems) will reduce saving and increase consumption to some degree, thereby helping to spur economic recovery.

Turning finally to directions for further research, we have focused on precautionary saving arising from earnings uncertainty in this paper, but the evidence suggests that precautionary saving arising from other uncertainties is of considerable importance and thus warrants careful analysis.

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**Table 6-3: Estimation of Precautionary Saving Model--III (WLS)**

| EC | Case I (All households) | | Case II (Younger households) | | Case III (Older households) | |
|---|---|---|---|---|---|---|
| | Coefficient | t | Coefficient | t | Coefficien | t |
| EY | 0.2724528 | 51.554 | 0.3184471 | 36.437 | 0.249377 | 29.63 |
| EASSET | -0.0029635 | -5.793 | 0.0025082 | 3.343 | -0.008352 | -11.235 |
| ESSW | 0.0022006 | 2.489 | 0.0054032 | 3.78 | 0.0039196 | 3.491 |
| VYD | -0.0000538 | -23.04 | -0.0000666 | -21.798 | 0.000042 | 5.605 |
| Egumma | -61.6553 | -5.577 | -49.88722 | -2.567 | 65.04713 | 4.051 |
| PRO1 | -40.79888 | -32.585 | -28.63522 | -15.879 | -48.51885 | -32.275 |
| PRO2 | -63.17125 | -50.471 | -61.83468 | -38.644 | -61.2855 | -29.781 |
| PRO3 | -91.65913 | -58.79 | -99.07317 | -46.453 | -74.58585 | -38.493 |
| EDU1 | -19.40087 | -11.361 | -5.232764 | -2.454 | -30.90228 | -9.963 |
| EDU2 | -18.23434 | -18.188 | -4.814539 | -3.953 | -35.86583 | -17.937 |
| EDU3 | -17.13889 | -12.083 | 0.3663143 | 0.185 | -40.88797 | -17.709 |
| AGE1 | -51.06991 | -23.66 | | | | |
| AGE2 | -16.49958 | -10.397 | | | | |
| AGE3 | -4.342747 | -4.069 | | | | |
| HEAd | 0.0126091 | 0.008 | -0.0757471 | -0.028 | 2.826426 | 2.017 |
| HOMEd | 0.4385566 | 0.647 | 2.200334 | 2.454 | 0.561033 | 0.594 |
| MARRd | 0.7783678 | 0.617 | 3.824145 | 2.364 | -1.219847 | -0.602 |
| KIDS | -0.0235754 | -0.07 | 1.61882 | 3.394 | 0.0998325 | 0.244 |
| Constant | 248.0331 | 58.768 | 161.294 | 39.593 | 274.9071 | 40.309 |

Notes:
(1)For the estimation of all households, number of observation is 2,317 households within 54 group and the Adjusted R-squared is 0.9394. For the estimation of older households, number of observation is 768 households within 28 groups and Adjusted R-squared is 0.9694. For the estimation of younger households, number of observation is 1549 households within 40 groups and the Adjusted R-squared is 0.90000. (2)Definitions of profession dummies (PRO) and education dummy (EDU) will be found in the notes of table 5. (3) Gumma is the ratio of risky assets among total financial assets. Egumma is the mean of Gumma within each group. (4) HEAd=1 if healthy, 0 otherwise; HOMEd=1 if my home owned, 0 otherwise; MARRd=1 if married, 0 otherwise.

### Table 6-4: Estimation of Precautionary Saving Model--IV(FGLS)

| C | Case I (All households) | | Case II (Younger households) | | Case III (Older households) | |
|---|---|---|---|---|---|---|
| | Coefficient | t | Coefficient | t | Coefficien | t |
| Y | 0.1516829 | 9.455 | 0.1937126 | 9.642 | 0.0610537 | 2.303 |
| ASSET | -0.0018542 | -1.31 | -0.0012716 | -0.715 | -0.001824 | -0.799 |
| SSW | 0.0210387 | 10.396 | 0.0212324 | 9.249 | 0.0109705 | 2.29 |
| VYD | -0.0002712 | -3.535 | -0.0005158 | -2.709 | -0.000246 | -2.819 |
| Gumma | 59.12472 | 1.887 | 61.72627 | 1.625 | 14.03672 | 0.258 |
| PRO1 | -0.5019564 | -3.462 | -0.3283565 | -1.956 | -0.653665 | -2.093 |
| PRO2 | -0.8470029 | -6.586 | -0.7375197 | -4.828 | -0.928119 | -3.206 |
| PRO3 | -1.183964 | -7.848 | -1.166243 | -6.518 | -1.115851 | -3.398 |
| EDU1 | 0.0198379 | 0.119 | -0.0250468 | -0.1 | -0.448973 | -1.735 |
| EDU2 | -0.1332177 | -1.378 | -0.01483 | -0.134 | -0.579698 | -3.012 |
| EDU3 | 0.2471288 | 1.306 | 0.3817304 | 1.782 | -0.302258 | -0.709 |
| AGE1 | 0.4740577 | 2.707 | | | | |
| AGE2 | 0.1958752 | 1.55 | | | | |
| AGE3 | 0.103292 | 0.896 | | | | |
| HEAd | 0.1169646 | 0.579 | 0.1501334 | 0.482 | 0.234134 | 0.852 |
| HOMEd | -0.0000626 | -0.001 | -0.0925916 | -0.812 | -0.06564 | -0.338 |
| MARRd | -0.0435403 | -0.149 | -0.1628339 | -0.533 | 0.536349 | 0.492 |
| KIDS | 14.59992 | 2.943 | 14.89655 | 2.668 | 7.668685 | 0.772 |
| Constant | 2.103905 | 5.51 | 1.948962 | 4.217 | 3.20533 | 2.808 |

Notes:

(1) Number of observation is 640, 196 , and 444 for estimation of all households, estimation of older households and that of younger households, respectively. Adjusted R-squared is 0.4395, 0.1274 and 0.5336 for the above three estimations, respectively.

# Chapter 3

# What Determines Precautionary Saving?*

*Abstract*

In this paper, we employ micro data on Japanese households to investigate the determinants of precautionary saving. In particular, we investigate the impact of income variance, assets, social security wealth, transitory income, and demographic and socioeconomic attributes on the amount of precautionary saving.

Our estimation results show that (1) of the three precautionary motives for saving, income variance has a significant impact only on saving for peace of mind. In other words, precautionary saving arising from earnings uncertainty appears to be largely or completely subsumed into saving for peace of mind. (2) Although the magnitude of precautionary saving arising from earnings uncertainty differs depending on the model we employ, we find that it accounts for 14.588% of total household saving when the most complete model is employed. This percentage is remarkably close to the corresponding figure of 12.579% in Chapter 2. (3) The occupation, educational attainment, and age of the household head, the ratio of risky assets, and homeownership appear to serve as proxies for the degree of risk aversion in some cases.

This paper contributes to the literature on precautionary saving in the following ways: (1) It is the first study to use directly reported data on the amount of precautionary saving, and moreover, it uses data not only on the total amount of precautionary saving but also on saving for each of three precautionary motives. (2)

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It validates the usefulness of my measure of earnings uncertainty by showing that it has a significant impact on certain concepts of precautionary saving. (3) It analyzes the impact of demographic and socioeconomic attributes on precautionary saving and hypothesizes that these variables serve as proxies for the degree of risk aversion.

## *1. Introduction*

Greater earnings uncertainty leads to a greater need for precautionary saving--i.e., saving required for the household to self-insure against uncertainty. In the prevailing climate of recession and increasing uncertainty (rising risk of unemployment, pension funding problems, unstable family structures, etc.), Japanese households appear to have altered their saving behavior and to have increased their saving for precautionary purposes.

In Chapter 2, I showed that the precautionary saving model applies in the case of Japan, that income uncertainty has a statistically significant[1] impact on Japanese household saving, and that precautionary saving arising from earnings uncertainty may account for 8.303% to 12.579% of total Japanese household saving. However, one limitation of my analysis in Chapter 2 is that it relies on a consumption function approach. The data source I use also collects direct information on saving for specific motives including three precautionary motives (saving for peace of mind (motive A), saving for care when bed-ridden (motive B), and saving for illness, disaster, and other uncertainties (motive C)), and in this chapter, I make use of this information. Knowing the realized magnitude of precautionary saving will enable us to evaluate the effect of earnings uncertainty on household saving from a different perspective, and the new results can be compared to our findings in Chapter 2.

More specifically, this paper will examine whether earnings uncertainty has a

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[1] “Significant” means statistically significant at the 5% level if not specially mentioned.

significant impact on saving for each of three precautionary motives and on overall precautionary saving and then uses the estimation results to calculate the magnitude of precautionary saving arising from earnings uncertainty as a ratio of precautionary saving and as a ratio of overall household saving.[2]

Secondly, we analyze the impact of demographic and socioeconomic attributes of households on precautionary saving. Demographic attributes include the age, health condition, and marital status of the household head and the number of children. Socioeconomic attributes include the occupation and educational attainment of the household head, the ratio of risky assets, and homeownership. To facilitate comparisons with the results of Chapter 2, we use the same variables employed in the estimation of the consumption function in Chapter 2.

Finally, we look for an underlying theory to explain the effect of demographic and socioeconomic attributes on precautionary saving. Many demographic and socioeconomic attributes may be proxies for preferences. For example, the ratio of risky assets and occupation may be proxies for the degree of risk aversion: the higher the degree of risk aversion, the lower will be the share of financial assets that is invested in risky assets and the more likely the individual will be to choose a stable profession such as the civil service. One of the strongest assumptions underlying the most widely used consumption or saving functions is that every households faces the same degree of risk aversion, time preference, and liquidity constraint. In other words, most precautionary saving studies such as Dardanoni (1991) assume a representative household with standard attributes, but it is well known that this assumption is not necessarily valid. In this paper, we relax this strong assumption about the homogeneity of household preferences and hypothesize that differences in

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[2] SFACH (1996) does not ask directly about the amount of saving arising from earnings uncertainty. Saving arising from earnings uncertainty may be included in saving for peace of mind (A) or in that for illness, disasters, and other uncertainties (C).

household preference lead to differences in household saving.

My main conclusions can be summarized as follows: (1) income variance is a significant determinant of saving for motive A (peace of mind) and of overall precautionary saving. (2) Precautionary saving arising from earnings uncertainty accounts for 4.499% to 14.588% of overall household saving, 14.624% to 53.905% of overall precautionary saving, and 27.592% to 89.472% percent of saving for peace of mind. (3) Household attributes such as the occupation, educational attainment, age, and marriage status of the household head and homeownership, which are possible proxies for the degree of risk aversion, significantly affect precautionary saving in some cases.

## *2. Data and Variables*[3]

This study uses data from the 1996 Survey on the Financial Asset Choice of Households (SFACH), a survey of 3,942 households (including single-person households) from throughout Japan whose heads are 20 or older. This survey collects very detailed data on income, saving, consumption, assets, liabilities, household portfolios, the amount of saving for the precautionary and other motives, socioeconomic and demographic variables, etc. In particular, it collects:

- detailed information on socioeconomic and demographic variables pertaining to the household, the household head, and the spouse of the household head (educational attainment, health condition, homeownership, occupation, marital status, children, etc.)
- detailed data on the household's income, saving, and consumption; on the amount and composition of its assets (financial assets and real assets) and liabilities, where financial assets are subdivided into four broad categories and fourteen

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[3] See appendix I for a more detailed explanation of the data.

narrow categories.

- detailed information on wealth holdings, wealth targets, and the flow of saving for the precautionary and other motives. Information is collected on the following twelve motives: retirement, one's children's education, one's own marriage, one's children's marriage, housing purchase, home renovation, durable goods purchases, leisure, bequests, and three precautionary motives: peace of mind, care when bed-ridden, illness, disaster, and other uncertainties. Therefore, there are nine reported values for precautionary saving: wealth holdings, wealth targets, and the flow of saving for peace of mind, for care when bed-ridden, and for illness, disaster, and other uncertainties.

Thus, this survey collects considerable information pertaining to precautionary saving and thus is ideally suited to an analysis of this topic.

The number of observations was reduced to 2,441 in five stages. As we have done in Chapter 3, households led by a female, households whose head is a student, households that report negative disposable income, households with a head who is 60 or older[4], and households whose head is unemployed or a part-time worker were excluded from the sample.

## *3. Model*

### *3-1 Precautionary Saving Model*

Starting from a stationary infinite horizon model, Merton (1971), Blanchard and Mankiw (1988), and Dardanoni (1991) all derive a closed form solution of the consumption function by assuming that the utility function is exponential with exponent $-\gamma$, that absolute risk aversion and time preference are constant, and that labor income (I) follows a random walk and is normally distributed with standard

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[4] We remain 60 year old households (n=53) in the samples because most part of these households are not yet entirely retired.

deviation $\sigma$:

$$E[C_{t+1} \mid I] = C_t + \gamma\sigma^2 / 2 \qquad (1)$$

Using the budget constraint, one can show that the level of consumption is given by:

$$C_t = (1/(T-t+1))A_t + Y^p - (\gamma(T-t)/4)\sigma^2, \qquad (2)$$

where T is life expectancy, A(t) is assets, and Y(p) is permanent income. This equation implies that consumption function is the same as that under certainty equivalence except for a negative term that depends on the degree of uncertainty ($\sigma$), the degree of risk aversion, and the life expectancy (T). We can easily derive the level of optimal saving by rearranging equation (2):

$$S_t = Y_t - C_t = -(1/(T-t+1))A_t + (\gamma(T-t)/4)\sigma^2 + (Y_t - Y^p), \qquad (3)^5$$

where Y(t) is current labor income and the variable ($Y_t - Y^p$) is therefore transitory income. According to equation (3), we can estimate household saving by the following consumption or saving function in practice:

$$S_t = b_0 + b_1(Y_t - Y^p) + b_2A_t + b_3VY_t + b_4\gamma_t + b_5T_t + v_t \qquad (4)$$

After rearranging equation (2), we derived the above saving equation where saving is jointly determined by transitory income ($Y_t - Y^p$), assets (real assets, financial assets and social security wealth), income uncertainty (VY as the proxy)[6], the degree of risk aversion ($\gamma$), and the rate of time preference (T).

### *3-2 Tobit Model*

To model the precautionary saving function satisfactorily, our specification must allow for the fact that most households are not saving for all three precautionary motives. For each of the three precautionary motives used in our study, there is a significant number of households with zero holdings of saving for that motive, and only 360 out of the 2,439 households reported saving for all three precautionary motives during the previous year. Table 2-2 shows the distribution of households by the number of

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[5] This equation is essentially in accordance with the consumption function we derive in Zhou (2000).

[6] See Chapter 2 for the derivation and calculation of VY.

precautionary motives for which they are saving, and as can be seen from this table, only a small proportion of households is saving for all three precautionary motives. 30% of households do not even have a wealth target for any of the three precautionary motives, and one-third of households have no wealth holdings for any of the three precautionary motives. 48% of households reported zero saving for all three precautionary motives during the previous year.

The failure of many households to save for all three precautionary motives leads to a very common problem in micro data—namely, the censoring of the dependent variable. Estimating the precautionary saving equations using only households with positive saving will lead to sample selection bias. Conventional regression methods fail to account for the qualitative difference between limit (zero) observations and non-limit (continuous) observations. When data are censored, the distribution of households is a mixture of discrete and continuous distributions. Therefore, the principal difficulty we face is to estimate jointly which motives households save for and the quantity of saving for each motive conditional on saving for that motive. To analyze this distribution, we define a new random variable S that is transformed from the original variable S* as follows:

$$S = 0 \qquad \text{if} \quad S^* \le 0$$

$$S = S^* \qquad \text{if} \quad S^* > 0 \quad \text{where}$$

$$S^*_t = b_0 + b_1(Y_t - Y^p) + b_2 A_t + b_3 VY_t + b_4 \gamma_t + b_5 T_t + v_t \qquad (5)$$

The distribution that applies if S*∼N[$\mu, \sigma^2$] is Prob(S=0)=Prob($S^* \le 0$), and if S*>0, S has the density of S*. The above regression model is referred to as a censored regression model or a tobit model with robust standard error[7] (Greene, 1997).

## *4. Hypothesis*

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[7] The use of household-level data typically leads to problem of heteroscedasiticity. However, without actually specifying the type of heteroscedscity, we can still make appropriate inference based on the result of tobit estimations with robust standard error.

One of most important predictions of this chapter is that income variance will significantly encourage household saving and discourage household consumption. Therefore, the coefficient (b3) of VY in equation (5) is expected to be positive.

According to the permanent income hypothesis of Milton Friedman, household income can be divided into two parts—we refer to the long lasting predictable part as "permanent income" and the income shock part as "transitory income." One would expect household consumption is determined primarily by "permanent income" and household saving to be determined primarily by "transitory income." In other words, the higher is transitory income, the more saving we would expect the household to do. As a result, we expect the coefficient (b1) of transitory income ($Y_t - Y^p$) in our saving model to be significantly positive.

Households' assets include financial assets, real assets, and social security wealth. Financial assets and real assets could be proxies for borrowing or liquidity constraints. Households with less financial assets or real assets will face substantially greater difficulty in obtaining loans thus face larger borrowing constraints. Social security wealth is income insurance for the retirement period and can be expected to discourage saving for retirement. As SFACH (1996) excludes saving for retirement from precautionary saving, one would not expect social security wealth to influence the amount of precautionary saving via its insurance effect. On the contrary, its wealth effect will encourage precautionary saving. In sum, our hypothesis about the main variables can be summarized as follows: $b_1$ , $b_2$, $b_3 > 0$.

## *5. Empirical Results*

### *5-1 Descriptive Statistics*

Table 1 reports descriptive statistics for the full sample of 2,441 households. The educational attainment of household heads is divided into four levels. About one-half (49%) of respondents are senior high school graduates, and 37% are junior college or college graduates. The average age of the household head is 44, and 64% of them are aged between 40 and 60. Most (78% of) household heads are salaried workers, most of whom (62%) are employed by private companies. 62% of households are homeowners, and 96% of household head regard themselves to be healthy. After dropping students, part time workers, and unemployed households, most (93%) of our respondents are married. The average number of children is 1.85, and the number of children ranges from 0 to 9.

The economic condition of households is indicated by the amount of their assets, social security wealth, and labor income. As we showed in Chapter 2, the distribution of all of these economic indices is the same as that of other large-scale household surveys in Japan, suggesting that the sample is representative of the total population. Turning to two other important variables, we find that the means of transitory income and the proportion of risky assets[8] are 2,870 yen and 6.01%, respectively. The proportion of risky assets is low compared to other developed countries such as the United States, suggesting that Japanese households are more cautious about investing in risky assets.

Finally, descriptive statistics concerning the dependent variable, the amount of precautionary saving, are also reported in Table 1. The average amount of precautionary saving (motives A, B and C combined) during the previous year was over 162,239 Japanese yen. The means of precautionary saving for motives A, B, and C were 78,451, 36,377 and 58,080 yen respectively. Table 2-1 reports descriptive statistics for each type of precautionary saving in greater detail for the full sample of 2,441 households. As we can easily observe from Table 2-1, saving for peace of mind (motive A) comprises more than half of total precautionary saving, and saving for care when bed ridden (motive B) comprises the smallest share in all cases.

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[8] We define risky assets as equities, trust funds, and investment funds such as Chukoku funds and MMF but excluding government bonds.

Wealth holdings for precautionary purposes comprise 42.3% of total wealth holdings, the wealth target for precautionary purposes comprises 28.9% of the total wealth target, and the flow of precautionary saving comprises 23.8% of the total flow of saving.[9] We would expect precautionary saving for earnings uncertainty to be included in saving for motives A or C, and in the next section, we will see if our expectations are confirmed.

### *5-2 Effect of Income Variance on Precautionary Saving*

As we found in Chapter 2, income variance as a proxy for earnings uncertainty would be expected to discourage household consumption and encourage household saving significantly. Moreover, income variance would be expected to have an especially strong positive impact on the precautionary component of saving. We estimated the impact of income variance on precautionary saving using a Tobit model with robust standard error.

Table 3-1 summarizes the estimation results where the dependent variables are saving for peace of mind (motive A), saving for care when bed-ridden (motive B) and saving for illness, disaster and other uncertainties (motive C). A priori, we would have expected precautionary saving arising from earnings uncertainty to be included in either saving for motive A or that for motive C, and our results show that income variance (VY) has a significant impact only on saving for peace of mind. VY also encourages saving for motive C, but its impact is not statistically significant. As a result, we conclude that precautionary saving arising from earnings uncertainty is largely or completely subsumed into saving for peace of mind.

To allow for the possibility that precautionary saving arising from earnings uncertainty is partly included in saving for motives B and C, we also estimated the

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[9] The 23.8% figure is remarkably consistent with the combined share of gross saving for the illness and peace of mind motives reported by Horioka & Watanabe (1997) (28.06%).

impact of VY on total precautionary saving (see Table 3-2). As a reconfirmation of the findings in table 3-1, the coefficient of VY is positive and statistically significant, and the magnitude of its coefficient (b3=0.00031) is almost equal to that of its counterpart in Table 3-1.

In order to make our results comparable to those in Chapter 2, we estimated the total amount of precautionary saving using the incomplete model as well as the complete model. The incomplete model includes only the main explanatory variables such as VY, assets, social security wealth and transitory income. The complete model includes not only these main explanatory variables but also a set of household attributes that could possibly serve as proxies for the unobservable degree of risk aversion ( $\gamma$ ) or the subjective rate of time preference (T) of households. The coefficient of VY in the complete is statistically significant and has a expected positive sign (b3=0.00031). However, the coefficient of VY in the incomplete model could be biased because this model omits at least two relevant variables—namely, $\gamma$ and T (Greene, 1997)[10]. The sign of the bias depends on the covariance between VY and the omitted variables. According to our estimation results, the coefficient of VY (b3=0.0000956) in the incomplete model is not statistically significant and somewhat downward biased compared to its counterpart in the complete model.

In sum, income variance (VY) affects saving for motive A and the total amount of precautionary saving significantly. Households protect themselves from the risk of earning uncertainty by saving for peace of mind.

### *5-3 Magnitude of Saving for Earning Uncertainty*

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[10] Letting β3 denote the true coefficient of VY and b3 its estimate, we obtain:

$$E(b_3) = \beta_3 + \frac{Cov(VY, OmittedVaribles)}{Var(VY)}\theta$$

. The direction of the bias in b3 will depend on the signs of the covariances and $\theta$, the coefficient vector of the omitted variables.

Next, we calculated the amount of precautionary saving arising from earnings uncertainty (Ef) as a proportion of saving for peace of mind (Af), as a proportion of total precautionary saving (PS), and as a proportion of total household saving (PS). The amount of saving arising from earnings uncertainty as a proportion of saving for peace of mind (lambda-1) was calculated as follows:

$$\lambda_1 = \frac{\sum_{i=1}^{n} Ef_i}{\sum_{i=1}^{n} Af} = \frac{\sum_{i=1}^{n} [-b_3 * V(\bar{Y})]}{\sum_{i=1}^{n} Af} \qquad \text{n=1,2,...2441}$$

Similarly, $\lambda_2$ (Ef as a proportion of total precautionary saving) and $\lambda_3$ (Ef as a proportion of saving for peace of mind) were calculated using the above equation but with the denominator replaced by total precautionary saving and total household saving, respectively.

Table 4 presents our estimates of the various measures of the magnitude of precautionary saving arising from earnings uncertainty. When the coefficient of VY from the incomplete model with only the main explanatory variables (b3=0.000956) is used, precautionary saving arising from earnings uncertainty comprises 4.499% of total household saving, 16.624% of total precautionary saving, and 27.592% of saving for peace of mind. When the coefficient of VY from the complete model (b3=0.00031) is used, precautionary saving arising from earnings uncertainty is about three times larger than when the coefficient of VY from the incomplete model is used. For example, precautionary saving arising from earning uncertainty as a proportion of total household saving ($\gamma_3$) increases to 14.588%.

Table 4 also shows the estimated magnitude of precautionary saving arising from earnings uncertainty as a proportion of total household saving ($\gamma_3$) that we obtained from the consumption function of Chapter 2. This proportion is estimated to be 8.303% when the coefficient of VY from the incomplete consumption model and 12.579% when the coefficient of VY from the complete model is used. Remarkably enough, these results are broadly consistent with the results based on the precautionary saving function. Therefore, $\gamma_3$ ranges from 4.499% to 8.303% in the case of the incomplete consumption/saving model and 12.579% to 14.5882% in the case of the complete consumption/saving model. Inasmuch as the estimated coefficient of VY in the incomplete model is downwardly biased, the results based on the complete model seem to be more reliable. The 12.6% to 14.6% share of precautionary saving arising from earnings uncertainty is very close to the estimate of Ogawa (1991) that the share of precautionary saving arising from earnings uncertainty was 10.53% in 1974 and 10.62% in 1975. Although our estimation results cannot be compared directly with those of Ogawa (1991) because of differences in our data and our methodology, the fact that we obtain comparable results suggests that the reaction of households to earnings uncertainty during the recession of the 1990s was similar to that at the time of the first oil crisis of 1974-75.

By the way, transitory income (YTP) has a positive and statistically significant impact on precautionary saving, as we hypothesized in section 4. As for the two remaining variables--assets and social security wealth (SSW), their impact on precautionary saving is volatile. Whereas assets have a positve and statistically significant impact on saving for motive A, the coefficients of assets and SSW are negative but completely insignificant in all other cases.

### *5-4 Effect of Household's Preference on Precautionary Saving*

Table 2-3 presents data on the flow of saving for the three precautionary motives broken down by various demographic characteristics. Saving for peace of mind (motive A) and saving for illness, disaster and other uncertainties (motive C) drop with age, but saving for care when bed-ridden (motive B) increases with age. One possible explanation for the above results is that old people save more for motive B because they face a higher possibility of becoming bed-ridden in the near future, whereas younger people face other more immediate uncertainties.

The relationship between occupation and the amount of precautionary saving is somewhat contrary to expectation. In all cases, the self-employed, farmers and fishermen, whose income uncertainty is generally the greatest, save the least, salaried workers in big private companies save the second least, salaried workers in small private companies save the second most, and civil servants whose earnings are usually the least uncertain save the most. Therefore, occupation could be serving as a proxy for some factor that influences precautionary saving. One possible explanation is that occupation is serving as a proxy for people's degree of risk aversion. For example, if people who are relatively risk averse are more inclined to choose stable occupations such as the civil service, this could explain the results we obtained.

Similarly, the amount of saving for motives A and C seems to be positively related to educational attainment, and healthy, married people, and homeowners save more than their counterparts in most cases. These results are also somewhat surprising because educational attainment and health can be regarded as a kind of employment or income insurance, self-owned homes can provide liquidity insurance in an emergency, and married people can pool their risks within the family, especially if both spouses work.

However, all of these findings are based on simple cross-tabulations, and thus other important variables have not been controlled for. For example, age is closely related to income and income is an important determinant of household saving, so the somewhat surprising relationship between age and saving could be spurious. Therefore, it is necessary to control for other factors by conducting regression analysis.

Table 5 summarizes the signs of the coefficients of the demographic variables in the precautionary saving regressions. In the equations for saving for peace of mind (Af), the direction of impact of most variables is the same as in the case of the cross-tabulations. However, only the coefficients of PRO4 (the occupation dummy for the self-employed, farmers and fishermen), EDU3 (the education dummy for the junior college educated), AGE4 (the dummy for the 50-59 age group), and the homeownership dummy are statistically significant. In particular, the self-employed, farmers, and fishermen save significantly less for peace of mind than those in other occupations, and the magnitude of the coefficients of the occupation dummies increases with earnings stability. In addition, younger people and homeowners save more for peace of mind than their counterparts. However, the coefficient of the proportion of risky assets ($\gamma$), one of the most likely proxies for the household's degree of risk aversion, is not statistically significant. Health condition dummy is positive but not significant as well.

Turning to the equations for saving for care when bed-ridden (motive B), the significant coefficients are those of PRO3 (occupation dummy for salaried workers in public agency or other organizations), PRO4, AGE4 (age dummy for people aged between 50-60), and marriage status dummy. These indicate that individual of PRO3 saves less but individual of PRO4 saves more than those of PRO1 (occupation dummy for salaried workers in small private companies) do. Besides, married and old people save more for motive B than their counterparts. The coefficient of the proportion of risky assets ($\gamma$) is positive but not significant in the case of motive B either.

Turning to the equations for saving for illness, disasters, and other uncertainties (motive C), the only variable whose coefficient is significant is the homeowner dummy, with the results implying that homeowners save more for this motive than their counterparts.

Because some of the variables have contrary effects on saving for the various precautionary motives, their effects on overall precautionary saving are generally insignificant and only the coefficients of the self-employed, farmer, and fisherman dummy (PRO4) and the homeowner dummy are statistically significant, with the results implying that the self-employed, farmers, fishermen, and homeowners save less for precautionary purposes than their counterparts.

In sum, although the direction of impact of most of the variables is the same as in the case of the cross-tabulations, only occupation, educational attainment, age, marriage status and homeownership are ever statistically significant. Contrary to expectation, people in unstable occupations (the self-employed, farmers and fishermen) save less for motives A and C, and married people save more for motive B than their counterparts, and homeowners save more for all precautionary motives except motive B than their counterparts. A possible explanation for these surprising results is that all or parts of the above variables are proxies for a household's degree of risk aversion. That is to say, risk averse individuals might be more inclined to choose stable but low-paying jobs, get married to pool risk with the spouse, or purchase a home for liquidity insurance in case of emergency. On the other hand, age and health variables could be proxies for a household's subjective rate of time preference although they are not statistically significant. As the degree of risk aversion and the subjective rate of time preference of households cannot be observed directly, their impact on saving is presumably captured by the above hypothesized proxy variables or reflected in the intercept term.

## *6. Conclusions*

In this paper, we employed micro data on Japanese households to investigate the determinants of precautionary saving. In particular, we investigated the impact of income variance, assets, social security wealth, transitory income, and demographic and socioeconomic attributes on the amount of precautionary saving.

Our estimation results show that (1) of the three precautionary motives for saving, income variance has a significant impact only on saving for peace of mind. In other words, precautionary saving arising from earnings uncertainty appears to be largely or completely subsumed into saving for peace of mind. (2) Although the magnitude of precautionary saving arising from earnings uncertainty differs depending on the model we employ, we find that it accounts for 14.588% of total household saving when the most complete model is employed. This percentage is remarkably close to the corresponding figure of 12.579% in Chapter 2. (3) The occupation, educational attainment, marriage status and age of the household head, and homeownership appear to serve as proxies for the degree of risk aversion in some cases.

This paper contributes to the literature on precautionary saving in the following ways: (1) It is the first study to use directly reported data on the amount of precautionary saving, and moreover, it uses data not only on the total amount of precautionary saving but also on saving for each of three precautionary motives. (2) It validates the usefulness of my measure of earnings uncertainty by showing that it has a significant impact on certain concepts of precautionary saving. (3) It analyzes the impact of demographic and socioeconomic attributes on precautionary saving and hypothesizes that these variables serve as proxies for the degree of risk aversion.

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*Table 4 Magnitude of Saving for Earning Uncertainty (Mean)*

| Saving for Earning Uncertainty as a proportion of | Saving Function | | Consumption Function (From Chapter 2) | |
|---|---|---|---|---|
| | When b3=0.0000956 (Incomplete Model) | When b3=0.00031 (Complete Model) | When a4=-0.0001263 (Incomplete Model) | When a4=-0.0002712 (Complete Model) |
| Overall Saving (%) | 4.49881 | 14.5882 | 8.303 | 12.579 |
| Overall Precautionary Saving (%) | 16.62375 | 53.90546 | | |
| Saving for Peace of Mind (%) | 27.59179 | 89.47188 | | |

Notes:(1)a4 is the coefficient of income variance in the saving function or consumption function. (2) Complete model includes not only main variables but also household's demograhpic variables. Incomplete model includes the main variables only. (3) All of the calculation is about the households that reported positive saving for precaution.

*Table 5 Signs of Attributes Varibles*

| | signs in Est. of Af | signs in Est. of Bf | signs in Est. of Cf | signs in Est. of Tf |
|---|---|---|---|---|
| PRO2, PRO3, PRO4 | M, M, M*** | M, M**, P*** | M, M, M | M, M, M*** |
| EDU2, EDU3, EDU4 | M, M**, P | P, P, P | P, P, P | M, P, P |
| AGE2, AGE3, AGE4 | M, M, M*** | M, P, P** | M, P, P | M, M, M |
| Gumma | M | P | P | P |
| HOMEd | P** | M | P *** | P*** |
| KIDS | M | M | P | M |
| MARRd | P | P*** | M | M |
| HEAd | P | M | P | P |

Notes:
(1)"M" means minus, "P" means plus.