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The Effects of Numeracy, Overconfidence and Risk Aversion on Portfolio Choice of the Aged and Their Implications to Capital Income Tax Policy in Japan

Shigeki Kunieda[1][2]

Chuo University

【Abstract】

Using a new comprehensive internet survey of aged male and female respondents in Japan, we consider the relationship of numeracy, overconfidence, risk aversion and risk asset investment and its implications for capital income tax policy in Japan. Numeracy decreases with age after early 60s. Educated older men tend to be overconfident about their numeracy. Numeracy and overconfidence reduce absolute risk aversion. Individuals with higher numeracy, more overconfidence and higher education tend to have risk assets in their household portfolio.

With consideration to the decline of numeracy of the aged and possible excess risk taking due to overconfidence , it is not desirable to encourage risk asset investment of the aged by special preferred tax treatment in Japan.

【Key Words】 numeracy, risk aversion, portfolio choice, capital income tax

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[1] Correspondence: Shigeki Kunieda, Chuo University, Hachioji-City, Tokyo, JAPAN
skunieda@tamacc.chuo-u.ac.jp

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1. Introduction

In the Japanese rapid aging society, more portion of national capital will be held by the aged. The portfolio choice of the aged has crucial implications for the Japanese economy. Some existing studies argue that rapid aging will not reduce risk investment. White Paper on Economy and Public Finance (2005) of Government of Japan claims that Japanese old people are risk lovers than younger people, so we do not need to expect risk reduction.

On the other hand, traditional finance theory suggest that old people should have more safe assets since their time horizon is shorter (Bodie et al. (1992)). Further, the recent literature points out that cognitive ability, especially numeracy, is important factor of risk attitude and risk investment choice. Since numeracy decreases with age, optimal risk investment decreases with age.

Portfolio choice of the aged is important for capital income tax policy in aging economies. In Japan, in order to encourage risky investment, the government introduced the tax preferred account for stock investment called "NISA (Nippon (Japan) version of Individual Saving Account)." While it may be desirable to encourage stock investment of the young households, much larger numbers of aged households use NISA accounts in reality. At the end of September 2020, 56.9% of the wealth in ordinary NISA accounts is held by the aged over 60years old. If numeracy level of the aged declines with age, and if overconfidence increase risk investment of the aged in Japan, encouraging risk asset investment of the aged is a questionable tax policy.

This paper studies the effects of numeracy and risk aversion on portfolio choice of Japanese people. For that purpose, we conduct a new comprehensive internet survey of 1758 aged male and female respondents. Using this new data, we consider the effects of numeracy and risk aversion on portfolio choice of the aged in Japan. In Section 2, we review the related literature briefly. In Section 3, we explain our new comprehensive internet survey. In Section 4, we look at numeracy and overconfidence during the old period. In Section 5, we consider the determinants of risk aversion. Since various risk aversion measures are proposed, we compare two alternative risk aversion measures. In Section 6, we consider the determinants of risk asset holding (have risk assets or not). In Section 7, we consider the determinants of the proportion of financial asset invested in risk assets. In Section 8, we discuss the implications for Japanese tax policy related to financial investment. There is a brief concluding remark.

2. Related Literature

With rapid aging around the world, the relation among cognitive ability, risk aversion, and portfolio choices are actively studied recently. Dohmen et al. (2011) point out the negative relation between cognitive ability, especially numeracy, and risk aversion. Bonsang and Dohmen (2015) argue that about 85% of the association between age and risk attitudes can be attributed to cognitive ability. Banks (2010) and Kim et al. (2012) find that higher cognitive ability is associated with more risk asset investment. Since cognitive ability decreases with age, it is rational that older households have less risk asset investment. This provides another reason why people should have less risk investment on average in addition to the traditional finance theory (Bodie et al. (1992)) explained above.

However, older people have more risk asset investment in Japan. Japanese White Paper on the Economy and Public Finance (2005) claims that Japanese old people are really risk lover based on their own survey of risk attitude of different generations. This claim is very different from the common observation that old people are risk averse in the previous studies in the other countries. Iwaisako (2009) argue that more financial risk taking of Japanese aged can be explained from the fact that older people have more assets. However, his analysis does not pay attention to cognitive ability and risk aversion of aged people.

On the other hand, only a limited number of studies consider the relationship among cognitive ability, risk aversion and portfolio choice in Japan. One exception, Nishimura et al. (2015), have an internet survey of 577 men from 20 to 69 years old. They find that cognitive ability decreases with age, and relative risk aversion (measured by the method of Barsky et al. (1997)) does not decrease much with age after 50 years old. They find that cognitive ability does not have association with relative risk aversion, but positive association with income and asset for 5o years old and later. However, they show only correlation among variables and do not have extensive econometric analysis.

In this paper, different from Nishimura et al. (2015), we conduct a more comprehensive survey of not only men but also women. The sample number 1758 is much larger than theirs. We use econometric method to analyze the relationship among variables, rather than only look at the correlations among variables. Also, we consider two alternative measures of risk aversion in the analysis.

3. Data

In order to analyze the determinants of portfolio choice of the aged in Japan、we conduct a new comprehensive internet survey. The samples are men and women from 45 years old to 79 years old. The initial number of samples is 1800. The samples are allocated to 14 strata of both men and women of 45 to 49, 50 to 54, 55 to 59, 60 to 64, 65 to 69, 70 to 74, 75 to 79 years old. The sample percentage of each strata are set to replicate the real population distribution of the Japanese national census in 2015. The questions of the survey include sex, age, family status, education, job, income, homeownership, loan, health status and others. For portfolio data, we ask the total mounts of financial assets and the percentage of assets invested in risky assets (stocks, investment trust and foreign currency denominated deposit). The questions also include numeracy test of respondents. (All questionnaires are provided by the author upon request.)

The internet survey was conducted by Cross Marketing Corporation, a Japanese internet marketing company with a good reputation in the internet research area. The respondents are registered at Cross Marketing Corporation. The survey was conducted from January 25 to 28, 2019. Before getting 1800 samples, initial data cleaning was already conducted in order to eliminate the respondents with unreliable answers such as choosing the same number choices in consecutive questions. In addition, since there are the respondents who seem not to understand the question in the answers to the question about absolute risk aversion, we eliminate those respondents. (Details are explained in the explanation of calculation of absolute risk aversion from the survey answers in Section 5.) It reduces the sample number from 1800 to 1758. We use these 1758 samples in Section 4 and 5.

One disadvantage of internet survey is that respondents are only internet users. Among the aged people, internet users are relatively limited. It is plausible that the aged respondents of our survey have higher numeracy than average aged people. Despite this disadvantage, internet survey provides a very cost-effective way to collect many samples of comprehensive data of numeracy, risk aversion and risk asset investment of aged people in Japan. Using this valuable data, we study numeracy, risk aversion and portfolio choice of Japanese aged in the next sections.

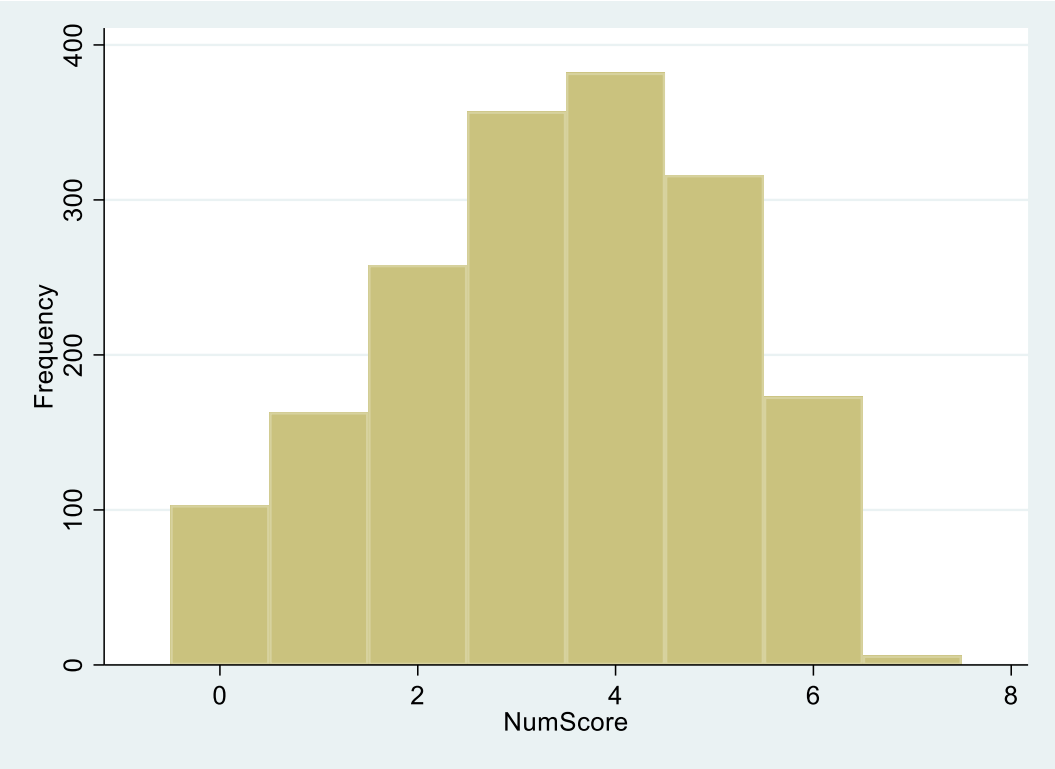
4. Determinants of Numeracy of Aged and Overconfidence

(1) Determinants of Numeracy

It is recently understood that cognitive ability is important determinants of risk aversion and financial decision. Among various aspects of cognitive ability, Bosang and Dormen

(2015) point out that numeracy is the most important ability related to risk aversion. In order to measure numeracy, we include seven numeracy questions in our survey. The questions are a mix of the questions proposed by Lipkus et al. (2001) (Japanese translation following Hirota (2015)) and Berlin numeracy test (Cokely et al. (2012)). Numeracy score (denoted by NUMSCORE), namely the number of correct answers, is used as an index of numeracy of the respondents in this analysis. The distribution of NUMSCORE is shown in Figure 1.

Figure 1 Distribution of Numeracy Score



The average of numeracy score is 3.38 points out of 7 points. The distribution seems to have enough variance for empirical analysis.

As in Bosang and Dormen (2015), we have regression of numeracy score with female (FEMALE dummy=1) and age plus the square of age as independent variables. In order to avoid multicollinearity, the age variables are used with centering (the mean of the sample is 61.4 years old) in the following estimations.

Basic statistics of variables used in Section 4 and Section 5 of these samples are in Table 1.

Table 1. Descriptive Statistics of Variables in Section 4 and Section 5

Model	Mean	Standard Deviation
NUMSCORE	3.377702	2.261326
OVERCONF	-0.03754	2.0211726
FEMALE	0.51479	0.499923
AGE	61.38567	9.770343
COLLEGE	0.415245	0.492904

The regression results are shown in the model (1) of Table 2. (We use Huber-White method to deal with heteroskedasticity problem.)

Table 2. Determinants of Numeracy and Overconfidence

Model	(1)	(2)
Dependent Variables	NUMSCORE	OVERCONF
FEMALE	-0.578269*** (0.078359)	-0.424739*** (0.102653)
AGE	-0.0013629 (0.003834)	0.089498* (0.0049694)
AGE^2	-0.000899** (0.0004362)	0.0007072 (0.0005777)
COLLEGE		0.2941812*** (0.1030343)
constant	3.761186*** (0.0725489)	-0.0085232 (0.1123489)
Sample (N)	1758	1758
R squared	0.0328	0.0228

The estimated coefficients of female is statistically significant at 1% level. As confirmed in many previous studies, the numeracy scores of women are lower than that of male by 0.58 points (out of 7 points) on average. The sign of the coefficient of age squared (after centering) is negative and statically significant at 5%. This implies that numeracy starts to

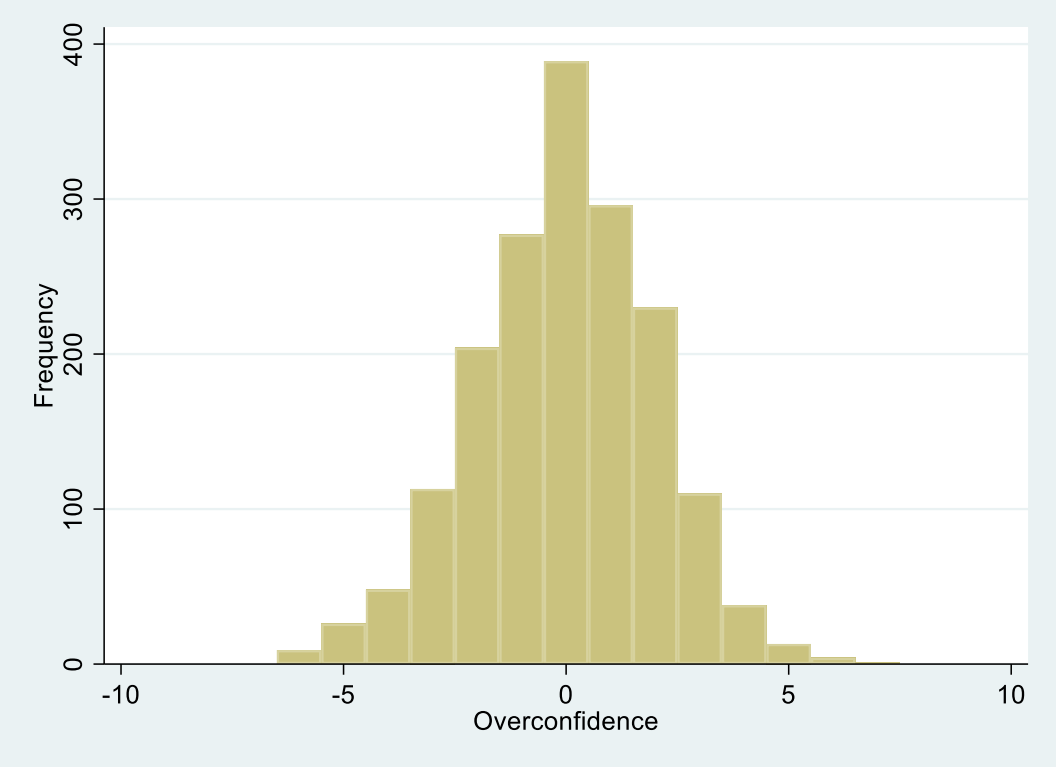
decrease after 61.4 years old. The finding of declining numeracy of the aged after early 60s is consistent with much of the previous literature such as Bosang and Dormen (2015).

(2) Overconfidence

In this survey, we include the question of self-evaluation of numeracy ("How many correct answers do you have in the part of numeracy questions?") The difference between the self-evaluated numbers of correct answers and the true numbers of correct answers measures the degree of overconfidence. This "overconfidence" index (denoted by OVERCONF) is positive when an individual believes that she can answers more questions than reality. As we show later, interestingly this overconfidence index has significant effects on risk aversion and portfolio choice.

The distribution of overconfidence index is shown in Figure 2. The mean of overconfidence index is -0.03754, so the average overconfidence is almost zero.

Figure 2 Distribution of Overconfidence Index



To know the determinants of overconfidence, we regress this overconfidence index

(OVERCONF) on female dummy (FEMALE=1 if female), age and the square of age. We also add college dummy (COLLEGE=1 if he/she has college education or higher.) as an independent variable. (We did not include college dummy as a possible determinant of numeracy ability in the estimation since the level of numeracy test is mathematics at junior high school. The descriptive statistics of variables are shown in Table 1 above.

The regression results are shown in the model (2) of Table 2. (In order to deal with heteroskedasticity, we use Huber-White method.)

The coefficients of female and college dummies are statistically significant. Female respondents relatively underestimate their numeracy, while male respondents relatively overestimate their numeracy. The positive coefficient of age means that older individuals are more over-confident. It is very interesting that higher education increases the degree of overconfidence. These results mean that older educated men tend to be more overconfident.

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5. Determinants of Risk Aversion

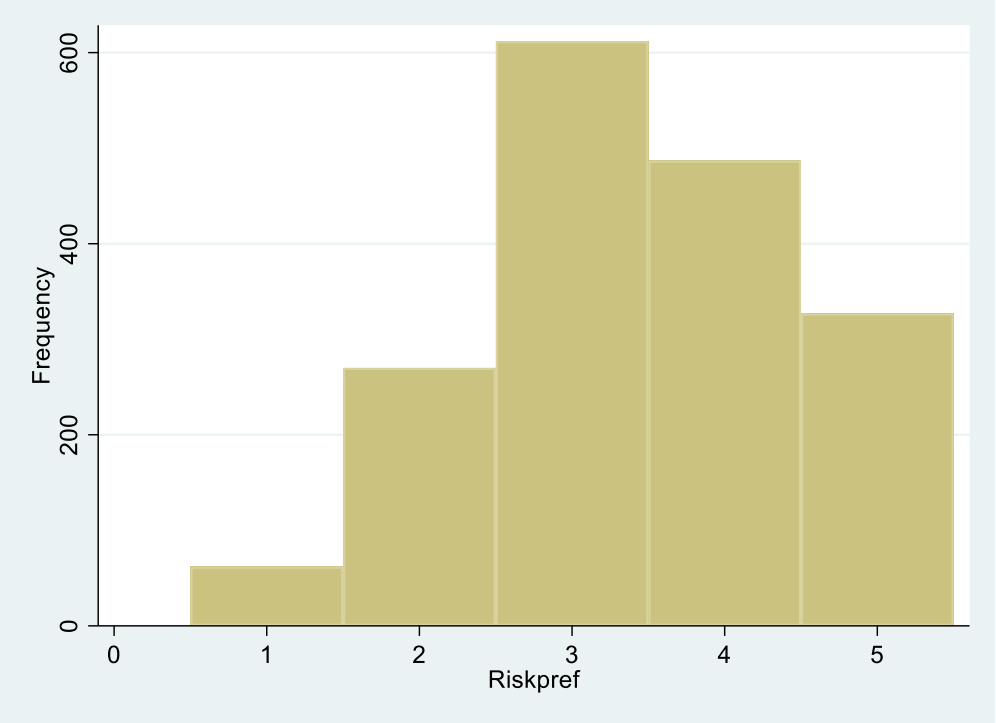
Risk aversion is considered as one important determinant of risk asset investment in portfolio choice. While there exist several ways to measure risk aversion, there are some discussion about the most significant measurement of risk aversion in portfolio choice decision. In this survey, we include two different questions to measure risk aversion. We also consider the effects of these two different risk aversion measures on portfolio choice in the next section.

(1) Self-evaluation of Risk Aversion

One measure of risk aversion used often in surveys is self-evaluation of risk aversion. Since it is subjective evaluation and does not provide the exact value of risk aversion, some researchers question usefulness of this measure. However, Andersson et al. (2013) points out that the aged people with lower cognitive ability seem to have more frequent mistakes. If the risk measurement using lotteries suffers more measurement errors, then self-evaluation is a better measure of risk aversion.

In this survey, we have self-evaluation of risk taking. The question in the survey is “How much risk do you take in comparison with others?” The answer choices are “1. I take risk aggressively. 2. I take risk relatively. 3. I am an average person with respect to risk taking. 4. I avert risk relatively. 5. I avert risk as possible.” The distribution of the answer choices is shown in Figure 3.

Figure 3 Distribution of RISKPREF Answer Choices



The distribution in Figure 3 shows that the risk preference of Japanese respondents is inclined toward less risk taking.

(2) Absolute Risk Aversion measured by Hypothetical Lottery

Traditionally, risk aversion is measured by using the questions about hypothetical lotteries. We consider the absolute aversion measured by hypothetical lottery used by many behavioral economics literatures such as Cramer et al. (2002).

The first absolute risk aversion question asks "There is a lottery that provides 20000 Japanese yen when it wins with the probability of 50% and provides nothing when it loses. Do you want to buy this lottery at 3000 Japanese yen?" The second question is "how much is the maximum price you would like to buy this lottery?" We use the answer to the second question in order to calculate the absolute risk aversion of the respondent.

There are 42 respondents who answer that they will buy this lottery at the higher price than the prize of 20000 Japanese yen. Since they may not understand the questions properly, we eliminate these respondents from the samples in the regressions in the following

regressions. The number of the samples is reduced to 1758.

Following Cramer et al. (2002), the absolute risk aversion (called "ABRISK") can be calculated from the answer to the second question.

$$\text{ABRISK} = \frac{\alpha z - p}{0.5*(\alpha z^2 - 2\alpha p z + p^2)} \quad (1)$$

where α: winning probability, z: prize of lottery and p: the price of lottery

From the assumption of lottery in the questions, α=0.5 and z=20000, p corresponds to the answer to the second question above. Thus, based on the answers to the second question, we can calculate the absolute risk aversion (ABRISK) using the equation (1). In the regressions below, we use ABRISK multiplied by 10000. Japanese White Paper on the Economy and Public Finance (2005) mentioned above also uses the absolute risk aversion as its measurement of risk aversion.

(3) Independent Variables

In order to know the determinants of risk aversion, we have two regressions. In the model (3), the dependent variable (RISKPREF) is the number of answer choices. Larger RISPREF means more risk aversion. Since the answer alternatives in the question about self-evaluated risk preference are ordered choices, we use the ordered probit model to analyze the determinants of self-evaluation of risk aversion. In the model (4), we conduct OLS. Its dependent variable is absolute risk aversion (ABRISK multiplied by 10000). In order to deal with heteroskedasticity, we use Huber-White method.)

The independent variables are female dummy (FEMALE=1 if female), age (with centering), the square of age, numeracy score (NUMSCORE), overconfidence index (OVERCONF), and college education dummy (COLLEGE=1 if college or higher education). In addition to the independent variables above, we also include the other variables that are recognized as possible factors affecting risk aversion by several previous studies. We include the dummy variable for the couple living in the household (COUPLE=1 if the respondent lives with his or her couple partner), the dummy variable for no job status (NOJOB=1 if no job) and the bad health dummy (BADHEALTH=1 if the respondents evaluate their health status as "a little bad" or "very bad").

Since the relation between risk aversion and wealth is an important topic, we also include the asset dummies for the holders of the assets between 2.5 and 10 million Japanese yen

(W10-), between 10 to 50 million yen (W10-50), between 50 and 100 million yen (W50-100) and equal and above 100 million (W100+).

Descriptive Statistics of additional variables in this section is shown in Table 3.

Table. 3　Descriptive statistics of variables in Section 5

Variables	Mean	Standard Deviation
Self-evaluated Risk Aversion	3.424915	1.065736
Absolute Risk Aversion	9.03348E-05	2.26252E-05
COUPLE	0.713879	0.452075
NOJOB	0.223549	0.416742
BADHEALTH	0.187713	0.390594
W10-	0.284983	0.451535
W10-50	0.3157	0.464926
W50-100	0.075085	0.263604
W100+	0.029579	0.169471

(4)　Estimation Results

The regression results of the model (3) and (4) are shown in Table 4.

Table. 4　Determinants of Different Measures of Risk Aversion

Model	(3)	(4)
Dependent Variables	Self-evaluated Risk Aversion	Absolute Risk Aversion(×10000)
Method	Ordered Probit	OLS
FEMALE	0.4665288*** (0.0572234)	0.0634880*** (0.0015214)
AGE	-0.0025899 (0.0029514)	0.0015214*** (0.0005476)
AGE^2	-0.000492	-0.000037

	(0.0002947)	(0.0000574)
NUMSCORE	0.011937 (0.017828)	-0.140996*** (0.0034407)
OVERCONF	-0.0494222*** (0.0139004)	-0.0114901*** (0.0029692)
COLLEGE	-0.0838818 (0.0574251)	-0.0017622 (0.0114869)
COUPLE	0.0867436 (0.0602444)	-0.0000816 (0.120839)
NOJOB	0.2208237*** (0.0697485)	-0.0042059 (0.0145842)
BADHEALTH	0.1991114*** (0.0725795)	-0.0084982 (0.014326)
W10-	-0.0658577 (0.0687698)	0.025947 (0.140813)
W1050	-0.1579741** (0.0708748)	0.0012789 (0.0147852)
W50100	-0.1579741 (0.0708748)	-0.0418204 (0.0147852)
W100+	-0.3545138* (0.1846838)	-0.0527561 (0.0367697)
constant		0.9266923***
Sample number (N)	1758	1758
(Pseudo) R squared	0.0275	0.0536

The regression results in Table 4 show that women tend to be more risk averse as the previous literature agree. Also, overconfidence reduces both self-evaluated risk aversion and absolute risk aversion. Thus, overconfident men tend to love more risks. In the case of absolute risk aversion in our survey, older respondents avert risk more, while individuals with higher numeracy avert risk less as in Bosang and Dorman (2015).

No job status and bad health have positive effects on risk aversion only in the case of self-evaluated risk aversion. Since self-evaluated risk aversion is subjective measure, it may be affected more by no job status and bad health. The college education and couple status do

not affect risk aversion. Since the coefficients of asset dummies are not statistically significant in most cases, it is not confirmed that risk aversion decreases with wealth.

6. Determinants of Risk Asset Holding

(1) Decision Makers of Financial Asset Allocation of Households

When we consider the survey response of individual characteristics and household portfolio choice, an important question is "who is the decision maker of the household portfolio among its family members?" While some studies focus financial decision makers of households, there are many studies not paying enough attention to this important issue. If the respondents' preference is not reflected in the financial decision of their households, there is no direct effects of the respondents' risk preference on portfolio of their households.

In our survey, we ask "How are you involved in the portfolio decision choice of financial assets of your household?" explicitly. The choices of the answers are "1. I mainly decide financial investment decision. ", "2. We discuss the financial decision among my family members, but it is rare that the household decision is different from my opinion." "3. We discuss the financial decision among my family members, but it is often that the household decision is different from my opinion." and "4. I am not well involved in the financial decision of my household." We use only the samples of the respondents who choose the answer 1 or 2 in the analysis of the determinants of risk asset investment in this and next section. We also eliminate the samples of the respondents who choose "I do not know/I do not want to answer" to the questions asking the amount of financial wealth, risk assets and annual income. Further, since we would like to see the financial asset allocation, we eliminate the respondents who choose the answer: "I do not have financial wealth." With these adjustments, the number of samples is 1078[3].

(2) Risk Asset Holding

Previous studies find the different response of risk asset investment choice at extensive margin and intensive margin. Risk asset investment choice at extensive margin means the

[3] In addition to the sample selection based on the question of decision makers of financial asset allocation of households, since we find that two respondents answer that they invest more than 100% of their portfolio in risk assets, so we exclude these two respondents. .

decision of whether households invest in risk asset or not. Risk asset investment choice at intensive margin means how much portion of portfolio is invested in risk assets when households hold non-zero risk assets in their portfolio.

In this section, we consider the determinants of risk investment choice at extensive margin. In this survey, risk assets include stocks, investment trust and foreign currency denominated deposit. Dependent variable RISKHOLDING is 1 if there is risk asset in their portfolio, but 0 if they do not hold risk asset in their financial wealth.

(3) Independent Variables

Numeracy score (NUMSCORE), overconfidence index (OVERCONF) and college education dummy (COLLEGE = 1 if college or higher education) are independent variables. For a risk aversion variable, first we use self-evaluated risk aversion in the model (5). Since this index is a categorical data, we use dummies for the different answer choices. If the respondents choose No. j of the answer choices, then the dummies RISKPREF j=1 (j=1, 2, 3 and 4). We do not use RISKPREF5 in order to avoid perfect linearity. In the model (6), we use absolute risk aversion ABRISK (multiplied by 10000) as an independent variable instead of self-evaluated risk aversion dummies.

Other independent variables include the independent variables used in the previous section: female dummy (=1 if female), age (with centering), the square of age, no job status dummy (NOJOB), couple status dummy (COUPLE) and bad health dummy (BADHEALTH). We continue to use the financial asset dummies, namely, the asset dummies for the holders of the assets between 2.5 and 10 million Japanese yen (W10-), between 10 to 50 million yen (W10-50), between 50 and 100 million yen (W50-100) and equal and above 100 million (W100+).

In addition, we add the other independent variables that are recognized as possible determinants of risk asset holding in the previous literature.

First, since it is known that homeownership affects risk asset investment, we add homeownership dummy (HOUSE=1 if having house). House is risk asset with volatile asset price, so homeownership may discourage further risk asset investment. However, some empirical studies find that homeowners have more financial risk asset than non-homeowners. Thus, the coefficient of HOUSE can be positive or negative. In Japan, since many homeowners use housing loan to buy their house, we add LOAN dummy (LOAN=1 if housing loan exists.)

Second, Kim et al. (2012) argue that even when their own time horizon of the aged is short, the aged who intend to leave bequest their children take financial risk. Thus, we ask the

purpose of savings in our survey. Answer choices include leaving bequest. We add bequest motive dummy (BEQUEST=1 if the purpose of savings is leaving bequest) as an independent variable.

The other independent variables are about income levels. We include income dummies for the income between 1 and 5 million Japanese yen (Y1-5), income between 5 and 10 million Japanese yen (Y5-10), income equal or higher than 10 million Japanese yen (Y10+).

Descriptive statistics of variables are shown in Table 5.

Table. 5 Descriptive Statistics of Variables in Section 6 and 7

Variables	Means			Standard Deviation
	All samples	Holding NO risk assets	Holding risk assets	
Sample Number	1078	480	598	
NUMSCORE	3.710575	3.454167	3.916388	1.5523652
OVERCONF	0.1113173	-0.19375	0.3561873	1.954126
COLLEGE	0.4981447	0.39375	0.5819398	0.5002286
RISKPREFD1	0.0426716	0.0125	0.0668896	0.2022095
RISKPREFD2	0.1846011	0.10625	0.2474916	0.3881537
RISKPREFD3	0.3413729	0.320833	0.3578595	0.4743904
RISKPREFD4	0.2829314	0.3125	0.2591973	0.4506324
ABRISK	0.000089	0.0000928	0.0000859	0.0000238
FEMALE	0.4554731	0.50625	0.4147157	0.4982446
AGE	62.0269	61.35208	62.56856	9.540911
HOUSE	0.8432282	0.791667	0.8846154	0.3637542
LOAN	0.1456401	0.164583	0.1304348	0.3529087
BEQUEST	0.0371058	0.03125	0.041806	0.1891087
COUPLE	0.7152134	0.677083	0.7458194	0.4515222
NOJOB	0.2458256	0.23125	0.2575251	0.4307755
BADHEALTH	0.1539889	0.1625	0.1471572	0.3611056
W10-	0.3191095	0.416667	0.2408027	0.4663479
W10-50	0.4100186	0.33125	0.472441	0.492065

W50-100	0.1029685	0.045833	0.1488294	0.3040587
W100+	0.0398887	0.008333	0.0652174	0.1957885
Y1-5	0.4888683	0.58125	0.4147157	0.5001081
Y5-10	0.3200371	0.28125	0.3511706	0.466707
Y10+	0.1632653	0.0979167	0.2157191	0.3697791

Since the choice between holding risk asset or not is binary choice, we use binary probit model. All regressions in this section use binary probit model with Huber-White method for heteroskedasticity problem.

(4) Estimation Results

The results are shown in Table 6. Average marginal effects (dy/dx) are also shown in Table 6.

Table. 6 Determinants of Risk Asset Holding

Models	(5)		(6)	
Method	Probit		Probit	
	Coefficients	dy/dx	Coefficients	dy/dx
NUMSCORE	0.1204432*** (0.0304952)	0.0378211	0.0935893*** (0.0290153)	0.031677
OVERCONF	0.0700768*** (0.023485)	0.0220052	0.0812511*** (0.0225299)	0.027501
COLLEGE	0.2125502** (0.0957244)	0.0667442	0.2191573** (0.0917088)	0.0741779
RISKPREFD1	1.890559*** (0.2980916)	0.5936658		
RISKPREFD2	1.360724*** (0.156375)	0.4272891		
RISKPREFD3	0.9924092*** (0.1348191)	0.3116324		
RISKPREFD4	0.690639*** (0.1366188)	0.2168717		
ABRISK(×10000)			-0.6700031***	-0.2267752

			(0.1951315)	
FEMALE	0.1339143 (0.1030739)	0.0420512	0.0027592 (0.0984877)	0.0009339
AGE	0.0061873 (0.0056673)	0.0019427	-0.0103853 (0.0054949)	0.0035267
AGE^2	-2.99e-06 (0.0004982)		0.000188 (0.0004914)	
HOUSE	0.2870504** (0.1235799)	0.0901384	0.294642** (0.119398)	0.0997271
LOAN	-0.2304357* (0.1329287)	-0.0723605	-0.0981567 (0.129517)	-0.033223
W10-50	0.5732275*** (0.146083)	0.1800026	0.5575906*** (0.1410887)	0.188727
W50-100	1.100459*** (0.2060326)	0.3455618	1.003847*** (0.1935578)	0.3397708
W100+	1.358651*** (0.3581926)	0.4266381	1.280231*** (0.3229137)	0.4333184
constant	-2.229209*** (0.3393459)			
Other Control Variables	yes		yes	
Akaike I.C.	1240.123		1323.357	
Schwarz criterion	1359.712		1427.997	
Sample (N)	1078		1078	
Pseudo R-squared	0.1953		0.1351	

The coefficients of numeracy, overconfidence and college education are statistically significant in both models. Individuals with higher numeracy and higher education have more probability of holding risk assets. At the same time, individuals with more overconfidence have higher probability of holding risk assets. In order to know the size of effects of numeracy and overconfidence on the probability of holding risk assets in their portfolio, we can estimate the marginal effect at a representative value (MER) in the model (6). For a 62-year-old college educated man with numeracy score NUMSCORE=4, and

overconfidence index OVERCONF= 0[4], if numeracy test score increases by 1, the probability of having risk assets increases by 4.3%. If overconfidence index increases by 1, the same probability increases by 2.5%. For female, those estimates are a little smaller. These are significant effects we cannot ignore when we consider capital income tax policy.

The coefficients of all self-evaluated risk aversion dummies are statistically significant at 1% in the model (5). The sizes of estimated coefficients of the dummies decrease with more risk averse answers. This means that the probability of holding risk assets is smaller for more risk averse individuals. Also, the coefficient of absolute risk aversion is negative and statistically significant in the model (6). Both models confirm that more risk averse individuals tend to have no risk assets in their households' portfolio. Akaike information criterion and Schwartz criterion are smaller in the regression with self-evaluated risk preferences. This means that the model with self-evaluated risk preference is better to predict whether risk assets are held in the portfolio of Japanese aged, as Andersson et al. (2013) point out, although absolute risk aversion also seems to be a good proxy of risk aversion in our analysis of risk asset holding.

The coefficients of HOUSE are positive and statistically significant. Homeowners tend to hold risk assets. The existence of housing loan seems to discourage risk asset holding, while the coefficients of LOAN are not statically significant in the model (6). The coefficients of the asset dummies for 10 million JPY and above are positive and statistically significant. The size of estimated coefficient is larger as the financial asset level is higher. This means that household with larger amount of financial asset tend to hold risk assets. On the other hand, most of the coefficients of income dummies are statistically insignificant (not listed in Table 4.) Income levels is not an important determinant of risk asset holding. The coefficients of couple status dummy, bequest motive dummy and no job status dummy (not listed in Table 4) are not statically significant either.

7. Determinants of Risk Asset Allocation

(1) Risk Asset Allocation

We now consider the asset allocation choice at intensive margin; namely how much portion

[4] Other assumptions include that ① he owns house without housing loan, ② he is married, ③ his financial wealth is between 5 and 10 million yen, ④ his come is between 1 and 5 million yen.

of the total portfolio is invested in risk assets. In our survey, we ask the percentage of the financial wealth invested in stocks, investment trust and foreign currency denominated deposits. The percentage of total share of these three risk assets in the financial wealth of household is denoted by RISKPERCENT.

(2) Independent Variables

In the model (7), we use self-evaluated risk aversion dummies (RISKPREFD1, RISKPREFD2, RISKPREFD3, and RISKPREFD4) as independent variables for risk aversion. We also use absolute risk aversion (ABRISK) as alternative risk aversion variables in the model (8). We use the same other independent variables as in the analysis of risk asset holding above.

Since there are many households who do not have risk assets in their asset in our sample, RISKPERCENT is censored value. We apply Tobit model to analyze the determinants of RISKPERCENT. All regressions in this section use the same Huber-White method for heteroskedasticity problem.

(3) Estimation Results

The regression results are shown in Table 7. We also have average marginal effects (dy/dx) of censored distribution (y>0) in both models in Table 7. They show the averages of the predicted effects of a unit increase of independent variables on share of risk assets when risk assets are held in their portfolio.

Table 7. Determinants of Risk Asset Allocation

Models	(7)		(8)	
Method	Tobit		Tobit	
	Coefficient	dy/dx (y>0)	Coefficient	dy/dx (y>0)
NUMSCORE	1.984723* (1.099311)	0.8553845	1.280291 (1.208546)	0.5324887
OVERCONF	1.59886* (0.8767419)	0.6890833	2.634826*** (0.9364944)	1.095856
COLLEGE	8.923793*** (3.433191)	3.834808	10.64249*** (3.714853)	4.410118
RISKPREFD1	84.35056***	54.61565		

	(7.920909)			
RISKPREFD2	61.65993*** (5.715957)	33.31296		
RISKPREFD3	45.25722*** (5.451578)	21.42085		
RISKPREFD4	29.35691*** (5.541368)	13.83108		
ABRISK(×10000)			-16.30989** (6.432016)	-6.78348
FEMALE	2.554941 (3.604093)	1.103685	-4.560621 (3.971203)	-1.890012
AGE	-0.1771336 (0.1958481)	0.0772808	-0.3257863 (0.2136014)	0.1387325
AGE^2	0.0026014 (0.0177141)		0.0097237 (0.0193699)	
HOUSE	15.09666*** (4.522399)	6.08793	15.89829*** (5.06128)	6.184992
LOAN	-8.562381 (5.20699)	-3.557175	-3.384358 (5.655081)	-1.387778
W10-50	15.40564*** (6.400084)	6.724586	17.31131** (6.750582)	7.310408
W50-100	27.89361*** (7.381855)	13.70593	28.04893*** (7.845325)	13.25284
W100+	32.39312*** (8.734494)	16.64158	33.5924*** (9.200561)	16.67228
Other Control Variables	yes		yes	
Akaike I. C.	6821.192		6972.867	
Schwarz criterion	6945.764		7082.49	
Sample (N)	1078		1078	
Pseudo R^2	0.0455		0.0232	

The estimation results in the models (7) and (8) are almost the same as the results of the analysis of risk asset holding choice.

Individuals with higher numeracy, higher education and larger overconfidence invest more in risky assets, although the coefficient of numeracy in the model (8) is not statically significant.

The sizes of coefficients of self-evaluated risk preference decrease with more risk averse answers. This means that the respondents who choose more risk averse answers tend to invest less portion in risky assets. The coefficients of absolute risk aversion is negative and statistically significant at 1% level. Individuals with higher absolute or relative risk aversions invest less in risk assets in their portfolio. Akaike information criterion and Schwartz criterion is smaller in the regression with self-evaluated risk preferences. As in the case of risk asset holding choice, the model with self-evaluated risk preference is better to predict the risk asset allocation in the portfolio of Japanese aged.

The coefficient of homeownership (HOUSE) is positive and large. Homeownership increases the share of risk assets in portfolio significantly. Also, households with larger financial wealth invest more portion of financial wealth in risk assets. While the estimated coefficients of other independent variables are not listed in Table 7, most of them including income dummies do not affect portfolio choice.

8. Implications for Tax Policy of Financial Income of the Aged

The results above provide important implications for capital income tax policy. The preferred tax treatment of stock-related income encourages stock investment of not only young people but also aged people. In Japan, aged investors hold much larger amount of ordinary NISA tax deductible accounts than young investors. However, traditional finance theory recommends that aged people should gradually reduce risk investment. In addition, our analysis shows that numeracy, which is necessary for sound risk taking in portfolio choice, decreases with age after early 60s. Further, it is important that overconfidence, frequently observed among old men with higher education, encourages excess risk taking in their portfolio choices. Then, tax preferred treatment of stocks may push overconfident investors toward too risky portfolio. While it may be useful to encourage young generations to invest more in stocks by tax policy, it is not desirable to encourage aged people to take more risk in their portfolio in Japan.

As we mention in Section 3, one disadvantage of internet survey is that respondents are only internet users. Among the old generations, internet users are relatively limited. It is plausible that the aged respondents of our survey have higher numeracy than average aged people. Thus, we expect that the numeracy of ordinary aged people decreases faster than

that of the respondents of our survey. This implies that the problem of encouraging risk investment of old people by tax policy can be more serious.

In the 2020 tax reform, Japanese government decided that ordinary NISA is revised into the new NISA with two pillars. In the first pillar, investors should invest in the installment investment trust schemes with diversified portfolio (called "Tsumitate NISA"). Only after investing in the first pillar, investors can invest in more risky investment trust in the second pillar. Since the installment investment trust schemes with diversified portfolio is preferred by young investors, this policy change reduces attractiveness of NISA scheme for older investors. Our analysis justifies this policy change that restricts the usage of ordinary NISA by old investors effectively in order to avoid excess risk taking in portfolio choice of the aged. We hope that this new NISA scheme succeeds to attract more young investors than old investors in Japan.

9. Concluding Remarks

In this paper, using the new comprehensive internet survey of 1758 aged male and female respondents in Japan, we consider the relationship among numeracy, overconfidence, risk aversion and risk asset investment. Numeracy decreases with age after early 60s. Educated older men tend to be overconfident about their numeracy. Individuals with higher numeracy and more overconfidence avert risk less. In their portfolio choice, individuals with higher numeracy, more overconfidence and higher education have more probability to hold risk assets. Individuals with more risk aversion tend to have no risk assets in their portfolio. While both self-evaluated risk and absolute risk measured by lottery are good proxies of risk aversion, self-evaluated risk aversion seems a better risk aversion proxy in the analysis of portfolio choice. Other influential factors include homeownership and financial wealth.

When we discuss capital income tax policy related to the portfolio choice of aged, we should consider the effects of numeracy decline and overconfidence of the aged seriously. Individuals with more overconfidence (typically educated old men) may take excess risk in their portfolio choice. It is not desirable to encourage risk investment of old investors by special tax preferred treatment of risk investment in Japan.

We hope that this study helps more deep understanding of portfolio choice of aged Japanese people and contribute to future policy debate about capital income tax in Japan.

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