7th Longevity Risk Conference

How will households adjust their consumption and investment decisions under longevity risk

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Outline

1. Introduction
2. Experiment Methodology
3. Variable Definitions and Statistics
4. Empirical Model and Results
5. Conclusions

1. Introduction

1. Introduction (1/2)

- In the last two decades, with improvements in quality of life, the health of the environment, and medical technology, the average human life expectancy has significantly increased.
- The aging population is becoming a serious issue that needs to managed in almost every country.
- As average life expectancy gradually increases, an individual's decision making processes and outcomes may become affected by longevity risk.

1. Introduction (2/2)

- Longevity risk can be briefly defined as the risk that the population might live longer, on average, than originally anticipated.

Country	• The budget deficiency makes a brake on economics development for one country.
Life insurance companies	• Insurance companies enhance the probability to become insolvency.
Individual	• If people live longer than their life expectation, they could face there is no enough money to support unanticipated extending living.

1. Introduction-Literature (1/2)

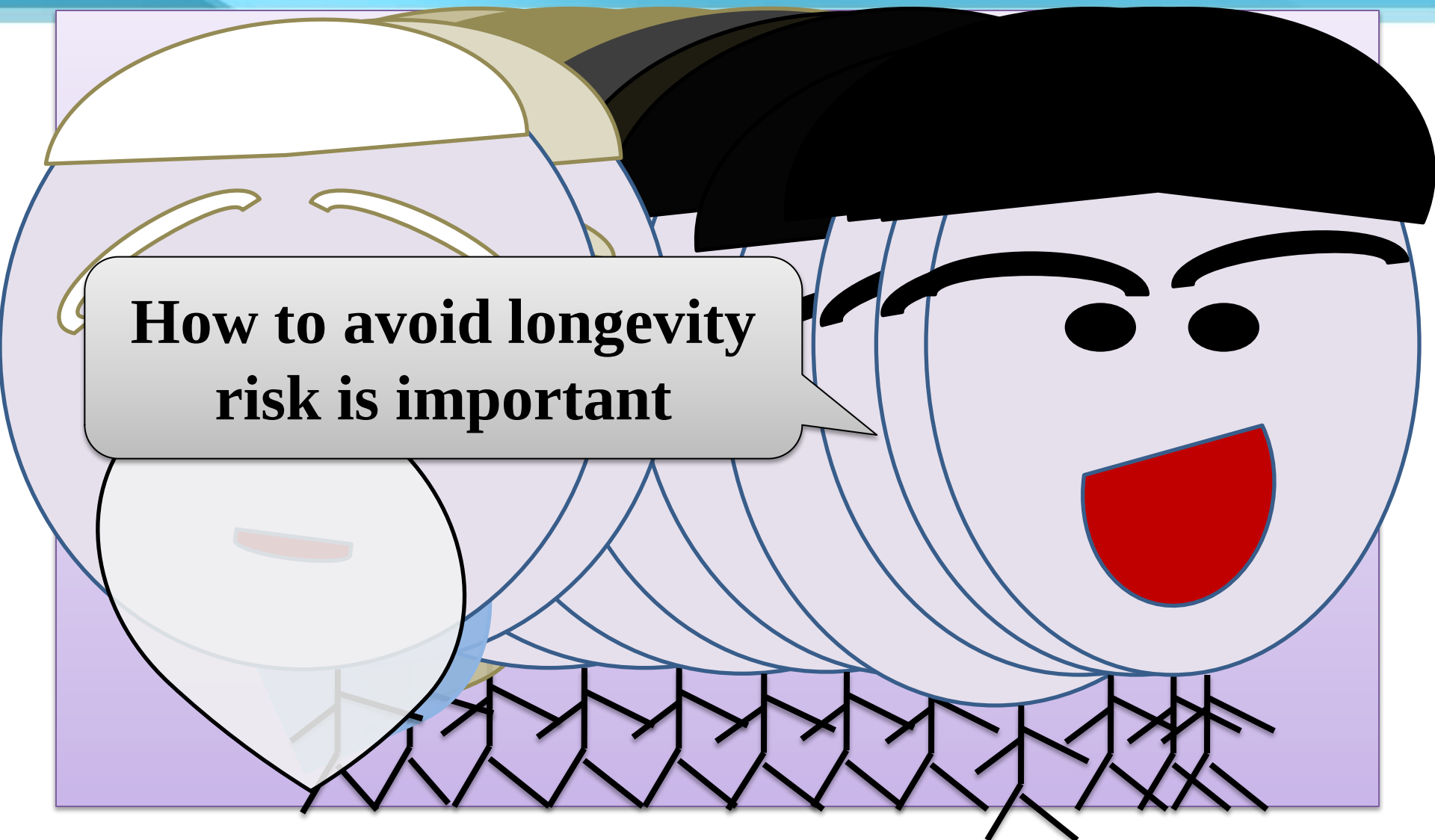
- Consumption Deciosion : “Life Cycle Hypothesis”, (Hamermesh (1984), Modigliani (1986), Haider and Stephens (2004), Mathieu (2006), Hurst (2008))
- Investment Decision: Bakshi and Chen (1994), Ang and Maddaloni (2005), Athanasoulis (2006), Huang et al. (2010)

1. Introduction- Motivation

- Many previous papers only consider the relationship between one-dimension decision and population structure due to the limitation of data.
  - We use the experimental method to consider two-dimension decisions jointly under longevity risk.
- It is difficult to track how households proceed with their consumption and investment decision for the long period.
  - Use the experimental economics could provide another way to analyze the households' behavior under longevity risk.

2. Longevity Risk and Experiment Methodology

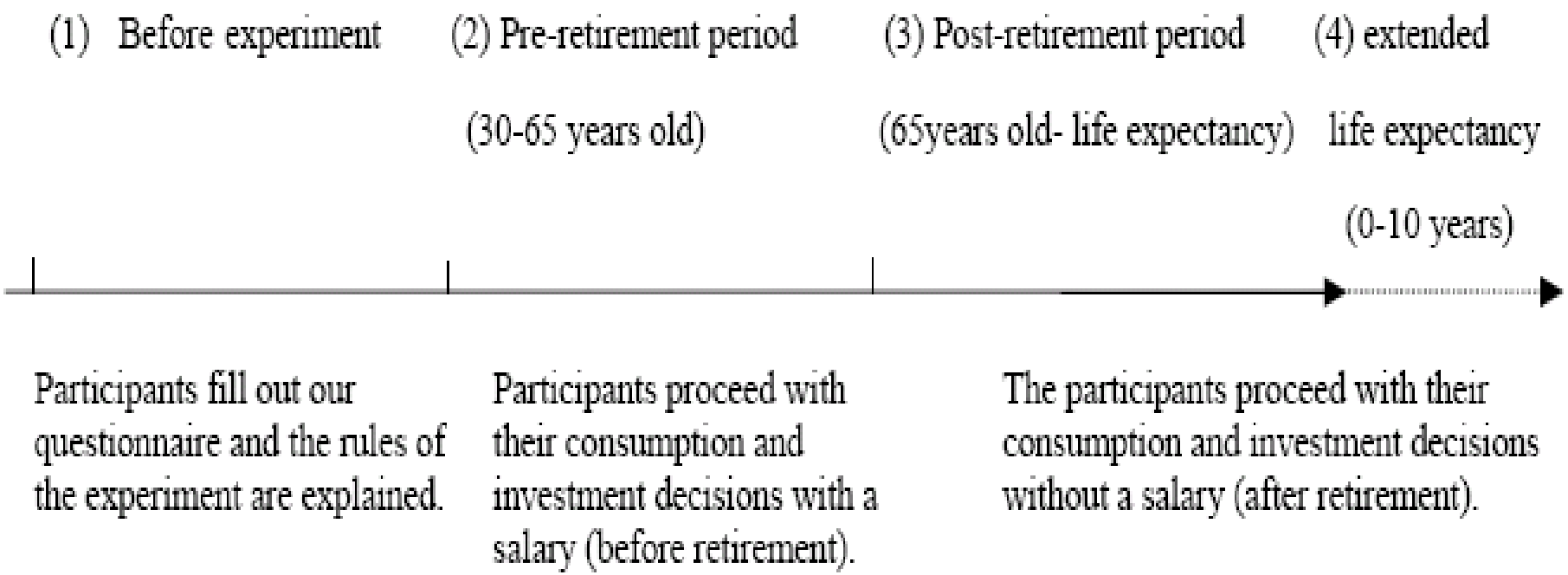
The longevity risk – The process of life



2.2 Experiment Methodology

Figure 1 Experiment Frame

Figure 1. Experiment Frame



2.2 Experiment Methodology

- This questionnaire mainly contains three parts including household demographic, health status perception and risk aversion.

Demographic

1.Gender
2.Education
3.Number of children
4.Family salary
5.Net wealth
6.The bequest motivation

Health status perception

1. Life expectation
2.Health status
3.Health-care expenditure

Risk aversion

Eisenhauer and Ventura (2003) method

2.2 Experiment Methodology

- Every five years means one turn in our experimental process.
- We assume the thirty years old as the start point in our experiment, the participants will have seven turn decisions until they become sixty-five years old. (pre-retirement period)

Table 1 The Experimental Turn Table

Life Expectancy	Under 64	65-69	70-74	75-79	80-84	85-89	Over 90
Experiment Turn	7 turns	8 turns	9 turns	10 turns	11 turns	12 turns	13 turns

2.2 Experiment Methodology

- All participants will be asked to join this experiment two times.

the first round

- Without longevity risk, participants will proceed with their decisions, and live until as their expectation in the questionnaire.

the second round

- By telling participants have the opportunity can extend their live age from zero to ten years, the participants proceed with their consumption and investment decision when understanding they could live to longer.

2.2 Experiment Methodology

- The purpose of this paper is investigating how the household proceed with their consumption and investment decisions under longevity risk by experimental economics methodology.
- We recruited nearly one hundred participants who their ages are nearly thirty years old and have married to join our experiment.

2.3 How to evaluate the risk aversion

- Eisenhauer and Ventura (2003) use the only question posed by the Bank of Italy in its 1995 Survey of Italian Households' Income and Wealth.

You are offered an opportunity of acquiring a risky security permitting you, with same probabilities (50% versus 50%), either to gain ten millions NT dollars or to lose all the capital invested. What is the most amount you are willing to pay this security?

2.3 How to evaluate the risk aversion

- $U(w) = 0.5U(w-z) + 0.5U(w-z+10)$ (2)
  - z reservation price
  - w net wealth (total asset minus total liability)
- $2U(w) = U(w-z) + U(w-z+10)$ (3)
  - $w-z+10$ the outcome of favorable state results in income
  - $w-z$ the outcome of favorable state results in income
  - $z<5$ risk averter will establish a reservation price
  - $z>5$ risk lover will pretend a reservation price
  - 5 risk neutral will set a reservation price
- A Taylor series expansion of the right-hand side of equation can extend around an income of w .
- $2U(w) = U(w) - zU'(w) + 0.5z^2U''(w) + U(w)$ (4)

  $+ (10-z)U'(w) + 0.5(10-z)^2U''(w)$

2.3 How to evaluate the risk aversion

- The Pratt-Arrow measure of absolute risk aversion can be derived as the follow.

$$ARA = -U''(w)/U'(w) = \frac{10-2z}{50-10z+z^2} \quad (5)$$

- We can investigate the participants with different risk aversion how to proceed with their consumption and investment decisions under longevity risk. (6)

2.4 Consumption and investment decisions

- The process of wealth accumulated before retirement period is shown as the equation (7).

$$W_{t+1} = (W_t + S_t - C_t)[\alpha_t(1+r_f) + (1-\alpha_t)(1+\tilde{r}_t)] \quad (7)$$

  - $t = 1,2,3,4,5,6,7$ (Pre-retirement: thirty years old to sixty-five years old)
  - W_{t+1} and W_t are respectively the household wealth at turn t and t+1.
  - S_t is salary at turn t.
  - C_t is the consumption amount at turn t.
  - r_f and $\tilde{r}_t$ are respectively risk-free return and risky asset return.
  - α and $1-\alpha$ are respectively percentages invest on the risk-less asset and risky asset.

2.4 Consumption and investment decisions

- **After retirement without longevity risk**
- In the first round, the participants proceed with their decisions without the longevity risk was described as the equation (8). is participants' expectation. The participants make the decisions with clearly know how long they will live.
- $W_{t+1} = (W_t - C_t)[\alpha_t(1+r_f) + (1-\alpha_t)(1+\tilde{r}_t)]$ (8)
  - $t = 8,9,...,n$ (Post-retirement: sixty-five years old to the participants' expectation)
- **After retirement with longevity risk**
- In the second round, the household will extend their life extension from zero to two turns. Under longevity risk, how the household proceed with their consumption and investment decisions after retirement was described as equation (9).
- $W_{t+1} = (W_t - C_t)[\alpha_t(1+r_f) + (1-\alpha_t)(1+\tilde{r}_t)]$ (9)
  - $t = 8,9,...,n,n+1,n+2$ (To extend the participants' life from zero to two turns)

3. Variable Definitions and Statistics

3.1 Variable Definitions-1

Table 1 Variable Definitions

Variable Names	Variable Definitions	Abbreviation
Demographic		
Gender	Gender is the dummy variable with value 1 if the head of the household is male, and 0 otherwise.	*Sex*
Education	The education years of the head of the household. We translate the rank into education years by the following rules. The education years are 9, 12, 16, and 18 years if education level is respectively junior high school or under, senior high school, university and graduated school.	*Edu*
Salary	The variable is the total amount of family salary in one turn of experiment.	*S*
Net Wealth	The net wealth of household at the thirty years old.	*NW*
House	House is the dummy variable with value 1 if the households have their own houses, and 0 if the households rent the houses.	*H*
Children	This variable means how many children under 18 years old does household have.	*Chi*
Bequest Motivation	How much money does the household have the willingness to left to their children.	*B*

3.1 Variable Definitions-2

Table 2 Variable Definitions

Health Situation Perception		
Life Expectancy	The participant predicts how long they will live.	*LE*
Health Status	The participant thinks the personal health status based on his own historical medicine record. This variable can be divided into several degrees including excellent, good, mediocre, illness and serious illness.	*HS*
Health-Care	The average amount of health expenditures is spent by the	*HE*
Risk Attitude		
Absolute Risk Aversion	The variable is defined as Arrow-Pratt measure of absolute risk-aversion (ARA).	*ARA*

3.2 Statistics-1

Table 3 The Percentages of Participants

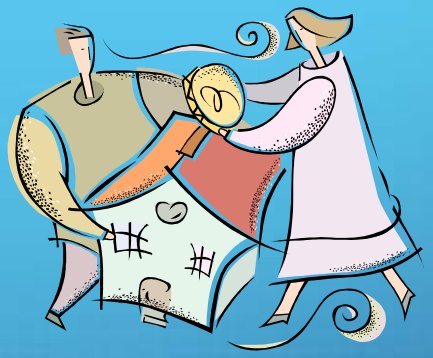
Variable		Percentage
Gender	Male	60.0%
	Female	40.0%
Education	Junior high school or under	0.0%
	Senior high school	13.3%
	University or college	60.0%
	Master degree	21.7%
	PHD degree	5.0%
Number of Children	None	51.7%
	One	23.3%
	Two	23.3%
	Three	1.7%
House	Purchase	70.0%
	Rent	30.0%
Health Status	Excellent	23.3%
	Good	38.3%
	Mediocre	35.0%
	Illness	3.3%
	Serious illness	0.0%
Risk Attitude	Risk aversion	80.0%
	Risk neutral	20.0%
	Risk lover	0.0%

Table 4 Statistics

	Mean	Standard Deviation	Median	Max	Min
Life Expectancy	72.58	7.73	75	90	60
Salary	2655.57	1074.83	2333.33	6666.67	1000
Net Wealth	29069.43	28925	20833.33	150000	6666.67
Health Expenditure	504.4333	451.6	333.33	2000	0
Bequest Motivation	90833.33	87410.17	50000	333333.3	0
Absolute Risk Aversion	0.1502	0.0777	0.195	0.2000	0

(All monetary amounts are originally recorded in NT dollars. In table 4, we translate the amount from NT dollars to US dollars by the exchange rate of NT dollars to US dollars is approximately 30. (NTD/USD=30))

4. Empirical Model and Results



4.1 Empirical model

- The main purpose of this paper is how households will adjust their consumption and investment decisions under longevity risk.
  - In the first round, the household proceed with their decisions without longevity risk.
  - In the second round, the household make their decisions with longevity risk when other conditions are same. We observe the differences of consumption and investment decisions in two rounds.

4.1 Empirical model

- Model 2:

$$\Delta C_j = \alpha_0 + \beta_1 Sex + \beta_2 S + \beta_3 Edu + \beta_4 Chi + \beta_5 W + \beta_6 Life + \beta_7 HE + \beta_8 B + \beta_9 ARA$$

$$\Delta Save_j = \alpha_0 + \beta_1 Sex + \beta_2 S + \beta_3 Edu + \beta_4 Chi + \beta_5 W + \beta_6 Life + \beta_7 HE + \beta_8 B + \beta_9 ARA$$

$$\Delta Stock_j = \alpha_0 + \beta_1 Sex + \beta_2 S + \beta_3 Edu + \beta_4 Chi + \beta_5 W + \beta_6 Life + \beta_7 HE + \beta_8 B + \beta_9 ARA$$

- C_j the ratio of average consumption to average salary in period j (j =1,2,3) .
- j respectively means all period, pre-retirement period and post-retirement period).
- ΔC_j means the differences of consumption-to-salary ratio in the first round (without longevity risk) and the second round (with longevity risk).
- $Save_j$ means average percentages that household put money on risk-free asset in each turn.
- $Stock_j$ means average percentages that household put money on risky asset in each turn.
- $\Delta Save_j$ and $\Delta Stock_j$ respectively means the differences of risk-free and risky asset ratio in the first round (without longevity risk) and the second round (with longevity risk).

Table 5 T-Test for Differences in Consumption and Save Decisions With and Without a Longevity Risk

	Definition	Mean	SD	t-value	p-value
ΔC_1	$(\frac{AC_1}{AS_1})_{\substack{without\ longevity \\ pre-retiremnet}} - (\frac{AC_1}{AS_1})_{\substack{with\ longevity \\ pre-retirement}}$	-0.0009	0.1286	-0.05	0.9596
ΔC_2	$(\frac{AC_2}{AS_2})_{\substack{without\ longevity \\ post-retiremnet}} - (\frac{AC_2}{AS_2})_{\substack{with\ longevity \\ post-retirement}}$	0.0422	0.2500	1.24	0.2204
ΔC_3	$(\frac{AC_3}{AS_3})_{\substack{without\ longevity \\ whole\ life}} - (\frac{AC_3}{AS_3})_{\substack{with\ longevity \\ whole\ life}}$	0.0170	0.1374	0.91	0.3674
$\Delta Save_1$	$(\frac{Save_1}{Save_1+Stock_1})_{\substack{without\ longevity \\ pre-retiremnet}} - (\frac{Save_1}{Save_1+Stock_1})_{\substack{with\ longevity \\ pre-retirement}}$	0.0404	0.1137	2.75	0.008***
$\Delta Save_2$	$(\frac{Save_2}{Save_2+Stock_2})_{\substack{without\ longevity \\ post-retiremnet}} - (\frac{Save_2}{Save_2+Stock_2})_{\substack{with\ longevity \\ post-retirement}}$	-0.02	0.1776	-0.89	0.3788
$\Delta Save_3$	$(\frac{Save_3}{Save_3+Stock_3})_{\substack{without\ longevity \\ whole\ life}} - (\frac{Save_3}{Save_3+Stock_3})_{\substack{with\ longevity \\ whole\ life}}$	0.0295	0.1174	1.95	0.056*

Note1: AC and AS refer to average consumption and average salary in period j respectively.

Note2: $0.1 <$ P-value $< 0.05 \rightarrow$*, $0.01 <$ P-value $\leqq 0.05 \rightarrow$**, P-value $\leqq 0.01 \rightarrow$***.

4.2 Empirical Results

- No matter in pre-retirement, post-retirement and whole life, there is nearly no variables except education will affect consumption decision.
  - People with lower education will consume less after retirement to alleviative longevity risk. However, they still maintain the same consumption level before retirement.
  - It is difficult to cut off same necessary expenditures such as diet, clothes, transportation, mortgage loan, education and raising children fee before retirement.

4.2 Empirical Results

- Even if some expenditure such as transportation, mortgage and raising children fee can be reduced after retirement, health care and medical spending will increase significantly at this moment.
- The consumption decision has its own rigid and inelastic characteristics. Based on our empirical results, it is difficult for households to reduce their consumption to avoid the longevity risk.

Table 7 The Relationship between Decisions and Backgrounds of Households

	Before Retirement		After Retirement		Whole Life	
	Consumption	Saving	Consumption	Saving	Consumption	Saving
Intercept	0.065	-0.060	0.315	0.150	0.241	0.037
	(0.699)	(0.693)	(0.363)	(0.546)	(0.167)	(0.806)
Gender	0.029	-0.033	-.031	-0.057	0.036	-0.043
	(0.392)	(0.275)	(0.646)	(0.250)	(0.292)	(0.159)
Income	6.16E-007	-3.17E-008	1.00E-006	-5.58E-007	6.00E-007	-3.06E-007
	(0.326)	(0.955)	(0.434)	(0.547)	(0.353)	(0.589)
Education	-0.024	0.016	-0.107	0.060	-0.047	0.011
	(0.305)	(0.431)	(0.028)**	(0.087)*	(0.051)*	(0.585)
Children	-0.003	0.066	-0.018	0.049	-0.023	0.064
	(0.864)	(0.000)***	(0.607)	(0.058)*	(0.209)	(0.000)***
Net Wealth	-3.87E-011	9.15E-009	1.09E-010	2.98E-008	4.11E-009	6.98E-009
	(0.999)	(0.636)	(0.998)	(0.349)	(0.852)	(0.719)
Bequest	-2.41E-009	5,43E-009	-1.12E-008	1.44E-008	-4.98E-009	1.35E-008
	(0.704)	(0.344)	(0.392)	(0.130)	(0.447)	(0.022)**
Health-care	-2.83E-007	5.34E-700	-1.80E-006	1.41E-006	-3.94E-007	4.69E-007
	(0.797)	(0.591)	(0.427)	(0.390)	(0.728)	(0.639)
Life Expectancy	-0.001	-0.003	0.001	-0.007	-0.001	-0.004
	(0.802)	(0.158)	(0.848)	(0.031)**	(0.525)	(0.071)*
Absolute Risk Aversion	0.044	0.329	-0.447	0.735	-0.104	0.343
	(0.841)	(0.097)*	(0.318)	(0.026)**	(0.642)	(0.086)*

Note1: The number in ( ) indicates P-value.

Note2: 0.1 < P-value < 0.05 →*, 0.01 < P-value ≦ 0.05 →**,P-value ≦ 0.01 →***.

4.2 Empirical Results-4

- We find that households prefer changing their asset allocation to reducing their consumption when they face the longevity risk.
- Households with greater risk aversion, more children and bequest motivation will decrease the proportion of risky asset under longevity risk.
- Households with higher life expectancy will increase their risky asset holding after retirement. The main results of this paper support households truly adjust their behavior to avoid the longevity risk.

5. Conclusions

Conclusion (1/2)

- The households prefer changing their investment decision to reduce their consumption when they face the longevity risk.
- Our empirical results support that households with characteristics such as greater risk aversion, more children and bequest motivation will reduce the proportion of risky asset under longevity risk.

Conclusion (2/2)

- The households with higher ARA and RRA will be more conservative when they face longevity risk.
- We find that households with higher life expectancy will put more money on risky asset after retirement period.

Thanks For Your Attention!